Welcome to the ALMA Science Verification Noticeboard

Introduction

This page gives an overview of the current status of ALMA Science Verification.

The Science Verification process

Science Verification (SV) is the process by which we demonstrate that ALMA is capable of producing data of the quality required for scientific analysis, i.e. data good enough to be included in the peer-reviewed literature. This work has been going on since early in 2011 (see the "prior to June 2012" target list below). We took the very first SV data-sets with as few as seven 12-m antennas but the results were nevertheless encouraging. Today (August 2012) there are 40 antennas at the Array Operations Site (AOS) - thirty-one 12-m antennas and nine 7-m antennas in the Atacama Compact Array (ACA) - and we typically observe with about twenty-five 12-m antennas and six or seven in the 7-m array. This means of course that the observations that we are making now should all have good image quality and excellent sensitivity.

Verifying upcoming ALMA capabilities

Until June 2012 we focused on reproducing the results that had already been obtained with other telescopes. With the new capabilities that are planned for Cycle 1 this approach is no longer feasible. Instead we will be carrying out a set of observations of specific objects chosen to demonstrate the full range of Cycle 1 capabilities as well as starting work on features that we expect to be available in Cycle 2. As has been the practice thus far, the reduced and calibrated data-sets will be available to the community for download as soon as the projects are successfully completed and analyzed. The list of Science Verification sources that may be observed before the start of Cycle 1 is shown below, but note that we do not expect to observe the full list: in most cases several possible objects are listed that are suitable for demonstrating a capability because we cannot be sure which will be available at the time when we are ready to make the observations. During this period, commissioning of additional capabilities will continue, so some observations of these objects will include post-Cycle 1 capabilities such as longer baselines and the more advanced observing modes such as on-the-fly mosaics. We will continue to confirm our ability to observe transient sources, so we do appreciate further suggestions for targets appropriate for those observations. We also hope to be ready to start the initial verification of new receiver bands, polarization measurements and solar observing in the coming months and we will be seeking participation by the community in those activities, probably on a "shared-risk" basis.

Collecting, reducing and releasing the data

Observations are carried out as part of Commissioning and Science Verification (CSV) activities, which currently take place on alternate weeks (alternating with Early Science observations). There are some planned breaks in the schedule, in particular a shutdown of operations for the month of February (the

Altiplanic winter), and partial shutdowns in September and Oct/Nov 2012 for upgrades to the correlator and power systems. Science Verification data is reduced by staff members of the ALMA Regional Centers (ARCs) and the Joint ALMA Observatory (JAO), and the process is coordinated by the JAO (contact: Catherine Vlahakis).

The list of targets below includes an estimate of when it is expected that the observations will be made and/or when the data might be released. The scheduling of SV observations is, however, necessarily flexible and the time needed to collect sufficient good-quality data and reduce it will vary considerably from target to target, so the dates given here are subject to change: some data releases will happen more quickly than others. We will keep the information here as up-to-date as is practical.

The results of SV observations are made public via the ALMA Science Portal, with no waiting period, as soon as satisfactory observations and data reduction have been achieved. We expect that each new release of data will be accompanied by notification to the e-mail circulation lists maintained by the ARCs. Due to the nature of SV, the data released may not cover all the aspects listed below and, as already noted, some targets may not be observed at all.

Current Targets (since June 2012)

The current list of SV targets, also presented in Table 1 of the Science Verification page of the ALMA Science Portal, is given below. In this table we list the targets, positions, observing bands and the currently anticipated timeline for the observations. They are grouped by the principal capability being demonstrated, but many of them are suitable for verification of more than one capability. Click on the links for more details.

A notice will appear under "Status" prior to the public release of a particular SV dataset. Once released, a link to the ALMA Science Portal will appear there. Once you have reached the Portal for your region, select ALMA Data from the menu on the left and then Science Verification.

Target	Coordinates (J2000)	Band	Cycle	Requirements	Timeline	Status
High Angular Resolution						
Water masers	multiple	7, 9	Cycle 1	Long Baselines	Nov/Dec 2012	
G34.26+0.15	18:53:18.6 +01:14:58	9	Cycle 1	Long Baselines	Nov/Dec 2012	
Ephemeris						
Mars	ephemeris	3, 6, 7	Cycle 1		Aug-Nov 2012	Observing started
Comet Garradd	ephemeris	3	Cycle 1		Aug 2012 or later	
Spectral modes						

CB54	07:04:20.9 -16:23 □:20 □□	7	Cycle 1		Oct 2012 or later	
Imaging extended structure						
VV114 / IC1623	01:07:47.2 -17:30:25	9	Cycle 1		Aug 2012 or later	Observing started
RXCJ1347-1145	13:47:31.2 -11:45:15	3	Cycle 1		Aug 2012 or later	Initial tests Aug 2012
Lambda Orionis	05:31:22 +12:05:00	3	Cycle 1		Oct 2012 or later	
Large mosaics						
HR3126 / IC2220	07:56:50.9 -59:07:33	3	Cycle 1	Software R9.1.1	Oct 2012 or later	
M16 (The Eagle Nebula)	18:18:52.7 -13:50:09	6	Cycle 1	Software R9.1.1	Oct 2012 or later	
NGC1512/10	04:03:54.3 -43:20:56	3	Cycle 1	Software R9.1.1	Oct 2012 or later	
Multi-field interferometry						
Fornax Cluster	multiple, ~RA 03h Dec -35	3	Cycle 1	Software R9.1.1	Oct 2012 or later	
Chamaeleon	multiple, ~RA 11h Dec -77	6	Cycle 1	Software R9.1.1	Nov 2012 or later	

Capabilities being Demonstrated - Cycle 1

High angular resolution

The longest baselines for Cycle 1 will be ~1km compared with ~400m in Cycle 0. We need to verify that coherence is maintained and that the calibration techniques, particularly phase correction, are working properly on these longer baselines. Bright compact sources are needed for this. The availability of the antenna stations for the longer baselines is coupled to the transition to the permanent power system, so it is not likely that we can make these observations until late in 2012.

Ephemeris

We need to demonstrate that the special steps required to observe and reduce the data on objects that move in RA and Dec work correctly in all cases, including both those objects that use the built-in ephemeris, e.g. planets and major moons, and those for which a special ephemeris has to be uploaded, e.g. comets. We also need to show that the Doppler corrections for such objects are made correctly. It is important that these are end-to-end observations as problems can arise in the data-capture and

data-processing parts of the procedure. Dynamical selection of phase calibrators is also required since the objects move.

Spectral modes

Cycle 1 capabilities include cases where the different basebands are used with different spectral modes (TDM/FDM) or different resolutions. The end-to-end process is more complicated than in Cycle 0, involving changes to the Observing Tool, the control of observations and the data reduction. In addition to making sure that the spectral setups are correct and that the data comes out of the final data reduction process with the correct frequency scales for the full range of possible combinations, we need to demonstrate that the calibration processes made with different spectral resolutions are all applied correctly. An important additional capability is the use of spectral averaging which will make the data volume much smaller in many cases but again introduces many additional steps in the end-to-end observing process which need to be verified. We need to observe sources with a range of different spectral characteristics for this.

Imaging extended structure

This is the most critical and complicated of the new capabilities for Cycle 1. We have to take well-matched data with the ACA and the 12m array and then combine these with the correct scaling and weighting into a single image (or rather spectral-image-cube). When single-dish measurements are included in the ACA observations we have to take and reduce those data in entirely different ways from the interferometric data and then bring the two data sets together. To establish that these processes are working correctly requires that we observe extended objects where we know exactly what the images should look like - e.g. planets - as well as spectral lines in objects with complex structure to show that we can image faint diffuse structures correctly even in the presence of bright compact features.

Band 9 observations will be particularly challenging because, in addition to the usual problems of getting good quality data and calibrating it at such high frequencies, the single-dish data requires a special observing technique to separate the signals from the two sidebands.

Multi-field interferometry

In Cycle 1 up to 15 sources can be included in an individual science goal. This can be done with the standard observing procedure (but see efficient multi-source interferometry below) so what needs to be verified is the end-to-end process including the generation of the scheduling blocks and data analysis.

Large mosaics

For Cycle 1 we plan to make mosaics of up to 150 "pointings". To provide adequate UV coverage we need to get round all the points in about 30 minutes, and this has to include sufficient phase and amplitude calibrations. This requires a time per point of 10 seconds at the maximum, which in turn implies reducing the inter-subscan time to no more than 4 seconds, which will give us ~50% of time on source, i.e. ~29% loss of sensitivity to overheads, as well as reducing the latency of the calibration measurements. We need to demonstrate that the software enhancements to do this are all working

correctly and that the end-to-end process including the creation of the grid of pointings and the reduction of the large images can be done in a practical manner.

Capabilities being Demonstrated - **beyond** Cycle 1

Further spectral modes

We are working on further enhancements including multiple spectral windows per baseband, which will make studies targeting multiple spectral lines more efficient, as well as on more complex LO-offsetting modes which should improve the rejection of spurious signals.

Efficient multi-source interferometry

In Cycle 1 the numbers of sources that can be observed in a single scheduling block is quite limited and for this reason only 15 sources can be included in an individual science goal. One of the major reasons for these limitations is the requirement to have individual calibration measurements with each source. A new multi-source observing mode is under development which can make use of the same calibrations on multiple sources in a restricted region of the sky. To demonstrate that this works and gives us the expected gains in efficiency we need to observe a set of at least 50 known objects in a region of no more than a few degrees in size.

Targets prior to June 2012

The following are the targets that were listed at the time of the Cycle 0 Call for Proposals and have been used to demonstrate the early (pre-Cycle 1) capabilities of ALMA. They are organized by the main capability that was being verified (though obviously in many cases several capabilities were involved). We do not expect to observe the sources on this list that have not yet been observed.

In some cases these projects were observed before 16 antennas were available and while many of the subsystems were still being tested, so they should not be construed to represent the quality of the data that can be expected from the system as it is today. They are provided here as a means for the user to become acquainted with the ALMA data structure, observing strategies and reduction techniques. Given that the data have been taken during the construction phase, there may be more idiosyncrasies present than will be expected during full operations, so we ask the user to please review carefully the CASA guides provided with the datasets that represent unique observing modes or strategies, as indicated below.

Target	Coordinates (J2000)	Band	Cycle	Status	CASA guide?
Ephemeris					
Io Atmosphere	ephemeris	7	Cycle 0 / 1	Observed but data problematic; hope to release by 10/12	

Uranus, Neptune	...	6, 7	Cycle 0 / 1	Observed (Uranus, Band 7); anticipated release by 10/12	
Mosaics					
Centaurus A	13:25:27 -43:01:08	6, 7	Cycle 0 / 1	Released (Band 6)	
M100 / NGC 5247	multiple, 12-13h	3	Cycle 0 / 1	Released (M100)	
NGC 4038/9	12:01:53 -18:52:38	3, 6, 7	Cycle 0 / 1	Released	Band 7 CASA guide
High spectral resolution					
TW Hya	11:01:51 -34:42:17	3, 6, 7, 9	Cycle 0	Released	Band 7 CASA guide
IRAS16293-2422	16:32:23 -24:28:36	6, 9	Cycle 0 / 1	Released	Band 9 CASA guide
High Resolution Spectral Survey					
Orion (BN/KL and OMC1)	05:35:14 -05:22:23	3, 6, 7, 9	Cycle 0 / 1	Released	
Low Spectral Resolution					
NGC 3256	10:27:51 -43:54:18	3	Cycle 0 / 1	Released	Band 3 CASA guide
Mixed modes					
HD163296	17:56:21 -21:57:22	6, 7, 9	Cycle 0	Observed (Bands 6, 7); anticipated release by 10/12	
Band 9 Imaging					
Arp220	15:34:57 23:30:11	6, 7, 9	Cycle 0 / 1	Observed (Band 9); anticipated release by 10/12	
High-z					
BR1202-0725	12:05:23 -07:42:32	7	Cycle 0 / 1	Released	
Recombination Lines					
Sgr A*	17:45:40 -29:00:28	3, 6	Cycle 0	Released (Band 6), Observed (Band3); anticipated release by 10/12	

Not Done: these were on the original list but not observed (we no longer plan to observe them)				
Lensed SMGs J1/J2	14:01:05 02:52:23	7	Cycle 0 / 1	Not done
NGC6334I	17:20:53 -35:46:58	3	Cycle 0	Not done
HH114mms	05:18:15 07:12:00	3	Cycle 0	Not done
R CrA Cloud Core	19:01:53 -36:57:21	?	Cycle 0	Not done
HD 107146	12:19:07 16:32:54	6, 7	Cycle 0	Not done

-- CatherineVlahakis - 21 Jul 2012

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