ALMA Scientific Advisory Committee

Report from Meeting of February 24-25, 2005

European Southern Observatory, Garching, Germany

ALMA Scientific Advisory Committee

J. Turner (USA, chair), L. Testi (Italy, vice-chair), A. Blain (USA), C. Carilli (USA),
P. Cox (France), Y. Fukui (Japan), D. Mardones (Chile), M. Momose (Japan), L. Mundy (USA),
J. Richer (UK), P. Schilke (Germany), E. van Dishoeck (Netherlands),
C. Wilson (Canada), S. Yamamoto (Japan)

Ex-officio

R. Kawabe (Japan), T. Wilson (Germany), A. Wootten (USA)

Other participants

A. Beasley (JAO), D. Emerson (NRAO), R. Laing (ESO), R. Murowinski (JAO), M. Tarenghi (JAO),
M. Holdaway (NRAO), D. Silva (ESO)

1 Executive Summary and Recommendations

The ASAC considered two charges from the ALMA Board at its February meeting in Garching. As part of Charge 1, the Committee discussed rescope options for ALMA, identified during the re-baselining process, which would mitigate the impact on the science while achieving cost savings to the Project. The Committee identified a number of acceptable options, including postponement of the implementation of two of four planned subarrays, reduction in the number of pads through a reoptimized configuration design, and delay in the implemention of the largest, Y+ array. Options presented by the Project that were deemed unacceptable by the Committee in terms of the serious impact on science were delays in the implementation of one of the two polarizations, one of the two IFs, or three of the four sub-arrays.

The issue of the scientific impacts of a number of antennas smaller than the original 64, corresponding to 60[1] operating antennas, is more complex. This portion of Charge 1 was discussed extensively by the Committee in Garching. The ASAC has previously stated, in its report of September 2004, that a 10% decrease in the number of antennas from the baseline project would have tolerable impact on the science, and would not rule out any of the Primary Scientific Requirements. The Committee

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[1] The original number of 64 antennas includes 4 antennas that will be undergoing routine maintenance and are unavailable for observing at any given time. Thus the baseline ALMA array actually consists of a maximum of 60 antennas operating simultaneously. Our comparisons to smaller arrays in this document refer to the 60 element operating array.

believes that a submillimeter array with 50 or more operating antennas would be a superb instrument that would surpass all existing arrays by a wide margin. The scientific capabilities of such a powerful continuum and line instrument at the high and dry Atacama site will be remarkable and unique. ALMA will be a spectacular complement to concurrent facilities such as SPITZER, SOFIA, Herschel, James Webb Space Telescope, and large ground-based optical telecopes.

On the other hand, the original specification of 60 operating antennas was driven by the need to do groundbreaking submillimeter science at the highest resolutions. Studying galaxies in the early universe requires the highest sensitivity and resolution, and is a Primary Scientific Requirement of ALMA. Equally strong requirements are placed on resolution and sensitivity by the imaging of structure and kinematics in the gas and dust of nearby protoplanetary disks on scales comparable to the gaps created by planets, which is the second Primary Scientific Requirement. Imaging of line emission from protoplanetary disks at such high resolution requires the full sensitivity of the 60 12-meter antennas; with them, ALMA's ability to study the internal kinematics of disks would be unequalled by any other instrument. The third Primary Scientific Requirement is to achieve the highest quality imaging in the millimeter and submillimeter bands, to match the quality of images from HST and ground-based adaptive optics. This too is highly sensitive to the number of antennas.

It is already a challenge to achieve the Primary ("Level 1") Scientific Requirements with 60 operating 12-meter antennas. While a smaller number of antennas, such as 50, would not necessarily preclude the primary goals, these groundbreaking programs would require significantly longer integration times and some science objectives could be put at risk due to systematic errors.

Dropping to significantly fewer than 50 operating antennas, for example, 40 antennas, is more serious. At 40 operating antennas, the observing time to reach a given sensitivity increases by a factor of 2.3 over the 60-element array. Such an array would also require a different operational model involving multiconfiguration observations to complete key programs, longer projects with increased costs per project, and would hinder the study of large samples of objects in the Level 1 category.

ALMA will be the premier instrument in its wavelength regime for two or more generations to come, the millimeter and submillimeter counterpart to the Very Large Array. While mindful of the fixed resources of the current project, the ASAC strongly urges the ALMA Project to consider any methods possible to eventually attain the original goal of 60 operating antennas.

Charge 2 to the ASAC concerned the issue of how to encourage collaboration through the individual partners of the ALMA project, and the scheduling of large programs in a way that would maximize the scientific productivity of the ALMA instrument given the requirement that the individual partners will have separate Program Review Committees (PRCs). There is a consensus within the Committee that there is some requirement for an International Program Review Committee to consider joint proposals, particularly very large proposals. However the scope of such an IPRC is not immediately clear. The Committee feels that further consideration of this issue is warranted.

2 Introduction

The ALMA Science Advisory Committee (ASAC) met on February 24 and 25, at ESO Headquarters in Garching. The meeting coincided with the coldest weather that Munich has seen in 30 years. In addition to the members in attendance in Garching, Diego Mardones participated by video conferencing from the Joint ALMA office in Santiago. The Committee was joined by members of the Joint ALMA office (JAO) from Santiago, and by members of the individual executives, from North America, Europe, and Japan, for discussions and presentations. The ASAC is grateful to ESO for its hospitality in sponsoring this meeting.

From the presentations of the Director Tarenghi, and Project Manager Beasley, the ASAC learned of the progress in the ALMA construction in Chile, in the staffing of the Santiago office, and the overall progress in the project, including the re-baselining effort. The ASAC eagerly looks forward to placement of the antenna contracts, a key step on the path toward the first scientific opportunities with ALMA. It is most gratifying to the Committee to see real progress toward this remarkable instrument.

The Committee heard a presentation from the ALMA-J(apan) project, given by Deputy-Director and Project Scientist for ALMA-J, R. Kawabe. The ASAC is pleased to see the progress made in ALMA-J, including the first antenna contract for three 12-meter antennas that was placed in early 2005, with delivery in 2007, and for a schedule for future antenna contracts for the 7-meter antennas of the Atacama Compact Array (ACA). Also reported were preliminary results of simulations to study the effects of systematic amplitude scaling errors when combining the data from the 64-antenna array with the ACA; amplitude errors appear to significantly affect image fidelity when these data are combined. The ASAC feels strongly that cross-calibration between the arrays will be very important for maintaining image quality when ACA and baseline ALMA data are combined, and urges the Project to make this a priority.

Two presentations were made to the committee on issues specific to the Charges. The first was a presentation by Project Manager Tony Beasley on the re-baselining project and options for rescope. The second was a presentation via video conferencing by Mark Holdaway on his new imaging simulations for arrays with different numbers of antennas.

3 Science and Re-baselining of ALMA

The first charge to the ASAC was:

Charge 1: Examine the status of ALMA re-baselining, including rescope options identified to date, and comment on the impacts that the proposed changes will have on ALMA's scientific capability. The ASAC is invited to comment on the scientific capability of a smaller number of antennas operating simultaneously, specifically 40 or 50.

Following the approach of the re-baselining process, the ASAC separated this Charge into two parts. The first question concerns the scientific impact of options for delaying portions of the project, or other cost saving measures that have been identified during re-baselining. The second question is the issue of the effects on the science of a smaller number of antennas. The two issues are discussed separately in the following sections of the report.

As a part of Charge 1, the ASAC heard a detailed presentation from Tony Beasley. Because re-baselining is in its final stages, the Committee did not receive any written materials from the Project on this Charge, instead receiving this information solely through the oral presentation. Beasley explained the process of re-baselining that the project has been undergoing since 2004. His presentation included a description of the re-baselining procedure and timescales, the move to the Project Management Control System (PMCS) for scheduling and budget, the search for hidden scope in the project, the identification and mitigation of risk, revised timescales, and budget. Beasley also presented the Committee with possible rescope options for the baseline project, or items that might be deferred, to be considered for Charge 1. The ASAC is impressed by the re-baselining effort and by the management plan. The Committee found Beasley's presentation extremely informative and useful for the consideration of Charge 1.

3.1 "Rescope options identified to date"

During the ASAC meeting, Beasley presented seven specific rescope options as well as a list of other possible items. Of the rescope options that were presented, the ASAC felt that the following items would be **acceptable** areas for rescope (in priority order):

1. *Postponing two sub-arrays out of a total of four sub-arrays planned.* The ASAC felt that ALMA operations can function well with just two subarrays, one for the science observations and one for technical work (measuring baselines for recently moved antennas, etc.) However, this would preclude simultaneous science observations of more than two frequencies, which may affect observations of objects with rapid variability, including perhaps solar flares.

2. *Reducing the number of pads that are needed through a new configuration design optimized for the new number of antennas in ALMA.* The ASAC understands that the project is looking at new configurations in light of the possibility that ALMA will not initially build 64 antennas.

3. *Delaying the implementation of the longest baselines (the Y+ array).* These baselines are the most difficult and expensive to implement, both technically and scientifically. The ASAC notes that this option would delay part of a Level 1 science goal (Goal 2, imaging of gaps in protoplanetary disks, requires the longest baselines) and should therefore be a very high priority item for implementation during the operations phase.

4. *Possible additional cost savings from construction of infrastructure such as the AOS, OSF, and Santiago buildings.*

5. *Adopting the semi-transparent vane instead of a more complicated calibration system, if it can be shown to meet specifications.* The ASAC notes that relaxing the calibration specifications

further would have a serious impact on image fidelity. However, the semi-transparent vane would clearly be a viable option if it can be proved to deliver the required accuracy.

6. *Implementing the amplitude modulated LO scheme, if required to have an LO solution for ALMA.* The ASAC notes that this option will probably cause higher phase noise, which will have a negative impact on high frequency and long baseline observations. Under the current specifications, the electronics are already the limiting factor in the best 5% of the weather.

The ASAC had the following comments on rescope options that were deemed **unacceptable** (in order of scientific impact). **All of these options should be implemented as originally planned.**

1. *Keep both polarizations.* The delay in implementation of one polarization would have a major scientific impact in that the sensitivity of each affected band would be reduced by a factor of $\sqrt{2}$, which is equivalent to a reduction in the number of operating antennas from 60 to 42. In addition, polarization observations would not be possible for each affected band.
2. *Maintain at least two sub-arrays.* Having only a single sub-array with ALMA would lead to large inefficiencies in determining baselines for recently moved antennas. Either the whole array would have to be used for baseline determination or the baseline observations would have to be done at whatever frequency was being used by the current science program.
3. *Keep both IFs.* The ASAC had considerable discussion of this issue, as the scientific impact depends on how it is implemented. If the implementation meant the loss of one polarization for all bands, it is subject to all the problems described in the discussion of front-end cartridges (all of the problems described in the first item of this list). If the implementation allowed a tradeoff between sidebands and polarization, then continuum and polarization observations would suffer a reduction in sensitivity by a factor of $\sqrt{2}$, while spectral line observing would be affected because of needing longer integration times on continuum observations of calibrators. Continuum programs make up 36 % of the total time in the Design Reference Science Plan (DRSP); many line programs also request continuum data for their interpretation, so that at least 50% of the programs in the DRSP are affected. In either of these implementations, the scientific impact would be serious, equivalent to reducing the number of antennas in the array from 60 operating antennas to 42, for only a modest savings in cost.

The possibility of saving costs in the area of computing was also raised. The ASAC feels that cuts in computing may have a large impact on the science community for ALMA and would make ALMA more of an expert instrument. Thus, the ASAC would prefer to be consulted if cuts become necessary in this area.

3.2 ALMA with “a smaller number of antennas... specifically 40 or 50 operating simultaneously”

ALMA will be a revolutionary instrument. The combination of the extraordinary site, the excellent technical developments made during ALMA’s development phase, and its large collecting area open new areas of scientific research and enable fundamental breakthroughs in areas ranging from local star and planet formation to first galaxy formation and cosmology. ALMA will be a qualitatively different instrument from existing millimeter arrays.

It is also true that the full scientific capability of ALMA will *strongly* depend on the number of antennas. In the following sections we discuss the scientific impact of decreasing the number of antennas, including general impact on sensitivity and imaging quality, the Primary (“Level 1”) Scientific Requirements, and the science as represented by the Design Reference Science Plan (DRSP).

3.2.1 General issues: Imaging Quality and Sensitivity

The scientific specifications of the array were established based on the idea that the Level 1 science goals could be accomplished with relatively routine integration times of 12 to 24 hours. This would allow for the study of representative samples of objects rather than single objects. Increasing the required integration times by a factor 1.5 to 2.3 (50 or 40 operating antennas, respectively) would decrease the sample sizes that can be studied, and increase the risk to successfully completing the program, by introducing potential systematic errors due to changing arrays and weather.

The requirements on sensitivity and image fidelity will shift a 40 operating element ALMA from being predominantly a one-configuration array to a multi-configuration array (§3.2.2). One of the consequences will be that projects will take much longer to complete, since the cycling of the array through the necessary configurations is likely to take of order a year. High stringency projects needing exceptional weather and good (u,v) coverage could become extremely difficult to complete due to the limited cross section for outstanding weather in multiple configurations.

The shift to longer integration times, multiple configurations, and longer project completion times also threatens one of the top level goals of ALMA: to enable millimeter wave interferometric imaging as a scientific tool for the broad astronomical community. The road to a smaller number of antennas will likely lead to more complicated operation and higher barriers to broadening the user base.

In addition, given that sensitivity goes linearly with collecting area but as square root of integration time, decreasing the number of antennas is an inefficient way of descoping an array, when one also considers the long term operating costs. For example, going from 60 to 40 operating antennas means that ALMA will be 2.3 times slower, with a commensurate increase in operations costs per project. This measure is relevant for ALMA; despite its tremendous stride forward in sensitivity, many of the key science goals are already ambitious, requiring more than 24 hour integrations with the 60 operating element array. Hence, the science throughput of the array will be significantly impacted by decreases in the numbers of antennas.

To summarize, ALMA with 50 or 60 operating antennas will be a superb instrument that will enable cutting edge observations beyond the reach of any other instrument. ALMA's high frequency capability and long baselines make it a unique scientific instrument for the forseeable future. Even with 40 antennas, ALMA will be a unique instrument, surpassing existing arrays by a wide margin. However, at 40 antennas, its capabilities become eroded compared to the baseline 60+4 ALMA. It would become less agile, and less capable of doing larger samples of objects. The impact would be greatest on projects requiring high sensitivity and/or high image fidelity, such as the demanding but high profile Level 1 science goals.

3.2.2 Primary ("Level 1") Scientific Requirements

Scientific Requirement I. Molecular gas in high redshift galaxies

The power of ALMA resides in its capacity to reveal dusty, star forming galaxies out to the highest redshifts: by imaging the dust and gas reservoirs of the systems, the fundamental fuel for star formation; by measuring their kinematics, unhindered by extinction; and by probing their physical and chemical properties. These submillimeter data on high redshift galaxies will provide key information for data gathered on instruments operating at optical, infrared, radio, and X-ray wavelengths. The Level 1 science goal has been quantified as the ability to detect molecular line emission from normal galaxies (i.e., Milky Way mass) out to the 'era of galaxy formation' at $z \sim 3$. Current arrays are limited to studying either the most massive galaxies (10 times or more the mass of the Milky Way) or strongly gravitationally lensed systems. The ability of ALMA to trace the molecular content and main atomic far-infrared cooling lines of normal galaxies at high redshifts and the high sensitivity achieved by ALMA in the continuum, which will allow detection of galaxies a few times less luminous than the Milky Way out to $z \sim 3$, will have a dramatic impact on our understanding of galaxy formation and evolution over cosmic time.

The Level 1 science specification is to detect the Milky Way at $z = 3$ in relatively routine integration times of $\sim$24 hours, including overheads, with 60 operating antennas (Report of the ASAC, September 2004). Such science is not precluded by a smaller number of antennas, but obviously programs will require more time. For 40 operating elements the time increases to 55 hours, which no longer can be considered a 'routine' observation. A sample of four such objects would require well over 200 hours of integration.

A potential issue is the question of whether systematic errors start limiting the sensitivity such that the noise decreases more slowly than the square root of time. For example, it may be that the weather and/or array configuration change substantially over the time it takes to complete a project. Adding such data together may not provide optimal sensitivity. In general, completing a program as quickly as possible is the best way to minimize systematic errors.

Overall, a re-baselined ALMA to 50 operating antennas would still open a unique window into the study of the gas and dust content of normal galaxies at large look-back times. However, dropping from 60 to 40 operating antennas would take this program from the regime of relatively 'routine' observations to being time intensive, and increases the risk of potential systematic errors.

Scientific Requirement II. Proto-planetary disks

The Level 1 science goal to image and trace the kinematics of gas and dust in circumstellar disks is challenging for the 60 operating element ALMA. Full achievement of this goal is at risk if the number of operating antennas drops to 40 or below.

The key scientific elements of this Level 1 science goal are: (1) to image the continuum emission from disks with sufficient resolution and sensitivity to find gaps and holes in disks caused by planet formation, (2) to image the molecular emission from disks with sufficient resolution and sensitivity to trace gas loss and the evolving chemistry of the disk, and (3) to image the gas kinematics with sufficient spatial and spectral resolution to learn about the thermal structure of the disk and the physical processes that are shaping the disk.

Science Element 1 to image dust continuum from protoplanetary disks requires excellent imaging quality, excellent sensitivity, and the highest resolution possible with ALMA. It is expected that gaps within disks will be typically less than 1 AU wide. Inner holes in disks are likely to be from a few AU to tens of AU in size. The disks will be complex structures which will require multiple configurations to properly image. Decreasing the number of antennas in the array increases the time requirements and increases the number of configurations needed to get high quality images. In addition, since the timescales of gaps is short compared to the disk lifetimes, surveys to find promising disk candidates are required; a smaller number of antennas will also limit the efficiency of this preparation phase for the detailed imaging.

Science Element 2 requires imaging of the emission from a variety of molecules to study the gas content and chemistry of protoplanetary disks and how that content evolves from protostellar to transition to debris disks. This is of paramount importance to understanding planet formation and the end-game of early evolution of other planetary systems. Such studies will be high-profile signature science for ALMA. No other instrument existing or planned has the resolution and sensitivity to challenge the definitive work that ALMA can accomplish. Sensitivity is the driving factor for this science.

Science Element 3, imaging the kinematics of gaseous protoplanetary disks, requires the highest imaging quality and sensitivity. The sensitivity of ALMA is challenged by the requirement for both $0.1''$ spatial and 0.1 km/sec velocity resolution. The latter is needed to untangle the thermal, turbulent, and orbital contributions to the kinematics and to potentially explore the vertical structure of the disk. Such information is vital to our understanding the role of turbulence in these accretion disks, the physical mechanisms enabling angular moment transport there, and the physical processes that limit or enable planet formation in disks. This kinematic information, precious and unique, comes at a price: it makes the greatest demands on the capabilities of ALMA.

Reducing the number of antennas in ALMA increases the risk of achieving each of these science elements because it reduces sensitivity and imaging quality. These risks can be partially mitigated by observing longer and observing in multiple configurations but these goals already required integrations of 8 to 30 hours in the 60 operating element array, and close to 90 hours for Science Element 3 (Report of the ASAC, September 2004). With a 40 operating element array, these observations become very difficult. Increasing integration times and configurations to compensate for loss of antennas puts additional stress on the relative and absolute calibrations requirements across weeks and months, which drive the final image quality.

Finally, a fundamental part of this Level 1 goal is to enable comparative studies by imaging a broad sample of systems covering ages from birth to the age of our Sun and covering a range of stellar masses. Increasing the required integration times to 50-100 hours per object essentially precludes study of large samples of objects.

Scientific Requirement III. Imaging Quality

The third Level 1 Science Requirement is that ALMA provide imaging comparable to other instruments such as the Hubble Space Telescope and ground-based adaptive optics systems. There are a number of factors that affect ALMA's imaging capabilities, such as calibration accuracy, pointing accuracy, and source complexity, but the number of antennas, and hence the number of baselines, is clearly a critical quantity. The original number of elements in ALMA was defined in order to achieve relatively uniform coverage of the visibility plane within a few hours of observing. This allows for high fidelity imaging for a wide range of spatial frequencies in reasonable integration times with a given configuration.

The Committee requested that Mark Holdaway perform imaging simulations for a grid of values for antenna number, N, to study the effects of array size on image fidelity. The simulations included noise, and were done for two sources with different kinds of spatial structures, using both maximum entropy and CLEAN image restorations, with longer integrations at smaller antenna numbers to give identical thermal noise. The simulations showed a strong dependence on N for on-source image fidelity. A similar strong dependence on N was observed in the noiseless simulations performed last year. The current simulations are more realistic than the previous ones in the sense that they include thermal noise; unfortunately, the current simulations were based on the existing ALMA configurations, which were optimized for 60 operating antennas, and not 40 or 50. This issue clearly needs more study. However, based on the trend of image fidelity with N, it appears safe to say that image fidelity will be an issue for higher dynamic range observations with ALMA, such as continuum observations, and that the image fidelity improves markedly with numbers of simultaneously operating antennas.

More fundamentally, the (u,v) coverage goes as the square of the number of elements. Going down to 40 antennas changes qualitatively the nature of the array, in that multiple configurations will be required to obtain adequate (u,v) coverage and the concomitant spatial frequency sensitivity to perform high fidelity imaging. Hence, many programs will require multiple configuration data, thereby extending the project over a longer time, increasing both the operational cost, and increasing the risk of systematic errors (e.g., calibration difference between arrays). For transient objects, e.g. comets, where multiple configurations are not an option, the image quality would suffer irrecoverably.

3.2.3 DRSP Analysis

The ALMA Design Reference Science Plan (DRSP) provides a representative set of high-priority projects that can be carried out by ALMA in the first few years of full operations. The research

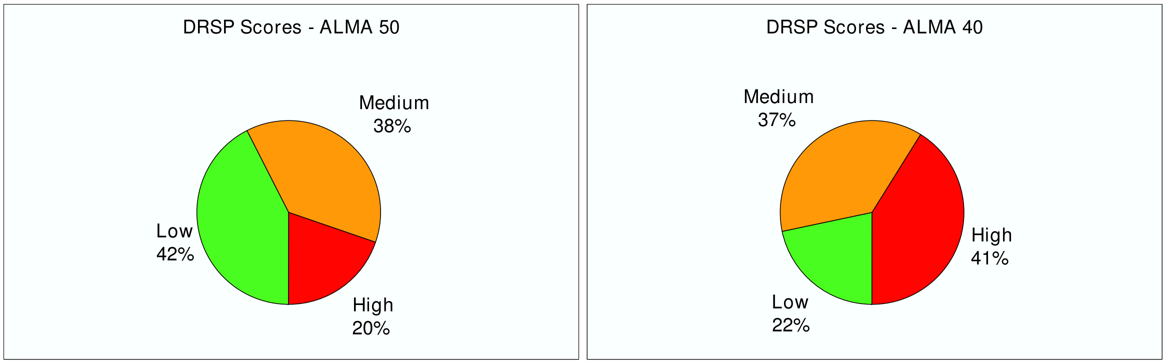

Figure 1: Percentage of DRSP programs and their risk categories for a 50 operating element array, or 40 operating element array.

areas are diverse and represent the current interests of the community in millimeter astronomy. This document can be used to measure the impact on current scientific interests when reducing the number of antennas. For each program, the ASAC has analyzed the question of whether the sensitivity or the image quality is key to achieve the scientific goal. Herewith the Committee provides a summary of this study, which reinforces the conclusions reached for the Level 1 science goals.

Following the risk analysis of the ALMA re-baselining process, the ASAC analyzed the impact on each DRSP project in the areas of both sensitivity and imaging. The risk was categorized as *high*, if there is substantial impact to the project, less than 50% of the objective can be accomplished; *medium*, 50-75% of the objective can be accomplished; or *low*, can be accomplished with the smaller array, with additional observing time. Risk is linked to observing time, such that large projects ($>$500 hours is “very large,” and $>$ 200 hours is “large”) with relatively small numbers of objects are generally in the high risk category. Projects requiring small amounts of observing time, or that can be scaled back in terms of numbers of objects, are in the low risk category. The scores were combined and are summarized in the attached Figure. While the analysis was not performed for the 60 element array, ASAC note that there will also be projects in the high and medium risk categories for this configuration as well, since many of the DRSP projects are already “pushing the envelope” of ALMA’s baseline capabilities.

For programs in observational cosmology, such as deep fields or the study of high-redshifted systems, the key issue is sensitivity. Most targets are faint, with modest dynamic range requirements. The main impact of decreasing the number of antennas is in integration time, requiring both surveyed area and numbers of sources to be trimmed, approximately as the square of the ratio $(N/60)$. Systematics (more observing sessions) and time (years to complete projects) also affect these programs.

For the study of nearby extragalactic systems, aside from the sensitivity, most of the programs require good to high dynamic range. Image quality is thus an important parameter in the study of the gas and dust content in nearby galaxies. A significant decrease in the number of antennas will directly affect a large part of the projects on nearby galaxies in the DRSP.

The projects on the chemistry in the interstellar medium, the structure of molecular clouds and cloud cores, and studies of star forming regions are driven equally by sensitivity and image quality. Decreasing the numbers of operating antennas to 40 will affect three-quarters of the current projects in terms of sensitivity and half in terms of imaging. The projects to image protostellar and protoplanetary disks (T Tauri, transition and debris) and to study the gas and dust distribution and disk kinematics all require high sensitivity and most of them good imaging quality. A loss in the number of antennas will add significantly to the required integration times and influence the final quality in the imaging of about half of the projects. The observing times requested for some of the signature projects are already large with 60 antennas: $\sim$90 hours per source for line images for kinematics and molecular distribution, 40 hours per source for a first-cut at disk chemistry, or 8 hours per source for transition/debris disks. An array with 40 antennas makes the completion of a study of a representative sample of objects, which is essential to explore evolutionary effects in disks, difficult and time consuming, and perhaps impossible. The combination of lower image quality and sensitivity, combined with a possible delay in the longest baselines, will probably rule out all of the proposed extrasolar planet programs in the DRSP, and also put at risk stellar and solar system programs.

4 Large Programs, Legacy Programs, and Joint Programs with ALMA

Charge 2: The ASAC is invited to continue its considerations of this September, 2004 charge, which may be combined with the continued development of ideas for implementing demonstration science elaborated at the same meeting.

Following thorough assessment of the pros and cons of policies in use at existing ground- and space-based facilities, including those currently operated by the ALMA Executives, ASAC is invited to consider policy recommendations on:

- *how to facilitate joint projects between scientists of different partners*
- *how to handle large proposals with significant scientific duplication*
- *whether provision needs to be made at this time for legacy projects, and if so, what mechanisms should be used for such projects.*

These complex, often-contentious issues should be addressed in the spirit of demonstrating how ASAC believes their recommendations, if adopted, would maximize ALMA's scientific impact.

Charge 2 to the ASAC concerned the issue of how to encourage collaboration through the individual partners of the ALMA project, and the scheduling of large programs in a way that would maximize the scientific productivity of the ALMA instrument given the requirement that the individual partners will have separate Program Review Committees (PRCs). There is a consensus within the Committee that there is a need for an international Program Review Committee to consider joint proposals, and particularly very large proposals.

The IPRC could potentially be a valuable advisory body to the Director in the scheduling of the array. There are two functions that the ASAC viewed as within the purview of an IPRC. The first function is to encourage joint programs between collaborators from different partners, which cannot be straightforwardly assigned to an individual PRC. There are circumstances in which such assignments might discourage collaboration. The other role is to monitor large programs on ALMA, specifically to avoid target or science duplications.

In the short time that the ASAC had to consider the Charges, and to discuss them at the meeting, it was unable to develop the idea of the IPRC and its scope. It is clear that there are many possible models that could be followed. The ASAC therefore recommends that Charge 2 be carried forward to the next face-to-face meeting, to give the Committee time to investigate this issue.

Appendix A: Charge to ASAC Meeting of February 2005

General Charge

The ALMA Scientific Advisory Committee (ASAC) will provide advice on those major issues presented to the ASAC by the Project Scientist or the ALMA Board that affect the science capabilities of ALMA and require decisions to be made or priorities to be set regarding project tasks and resources. The ASAC will be kept informed of progress and developments in ALMA through periodic reports and briefings by the Joint ALMA Office and shall meet at least twice a year. Reports of the ASAC's deliberations will be made in writing to the Board by the Chairperson of the ASAC following each Committee meeting, on a schedule specified in advance by the Board. The Project Scientist serves on the Committee ex officio.

Charge for the Meeting of 24-25 February 2005 (Garching)

The ASAC is requested to consider the following topics, and make recommendations to the Board that include your priority or time scale where your recommendations require expenditure of ALMA's fixed resources.

1. Examine the status of ALMA re-baselining, including rescope options identified to date, and comment on the impacts that the proposed changes will have on ALMA's scientific capability. The ASAC is invited to comment on the scientific capability of a smaller number of antennas operating simultaneously, specifically 40 or 50.

2. ASAC is invited to continue its considerations of this September, 2004 charge, which may be combined with the continued development of ideas for implementing demonstration science elaborated at the same meeting:

Following thorough assessment of the pros and cons of policies in use at existing ground- and space-based facilities, including those currently operated by the ALMA Executives, ASAC is invited to consider policy recommendations on:

a. how to facilitate joint projects between scientist of different partners

b. how to handle large proposals with significant scientific duplication

c. whether provision needs to be made at this time for legacy projects and, if so, what mechanisms should be used for such projects.

These complex, often-contentious issues should be addressed in the spirit of demonstrating how the ASAC believes their recommendations, if adopted, would maximize ALMA's scientific impact.

Please deliver your written report to the ALMA Board by 22 March 2005.

Appendix B: ASAC members and attendees

ASAC Members in attendance

Chris Carilli (NRAO Socorro)
Pierre Cox (IRAM)
Yasuo Fukui (Nagoya University)
Diego Mardones (U. Chile), by video conference from Santiago
Munetake Momose (Ibaraki University)
Lee Mundy (Maryland)
John Richer (Cambridge)
Peter Schilke (MPIfR, Bonn)
Leonardo Testi (Arcetri) – Vice-Chair
Jean Turner (UCLA) – Chair
Ewine van Dishoeck (Leiden)
Christine Wilson (McMaster University)
Satoshi Yamamoto (Tokyo)

ASAC Ex-officio Members

Ryohei Kawabe (NAOJ)
Thomas Wilson (ESO)
Alwyn Wootten (NRAO)

Project and Partner Representatives

Massimo Tarenghi (JAO)
Anthony Beasley (JAO)
Richard Murowinski (JAO)
Darrel Emerson (NRAO)
Mark Holdaway (NRAO), by video conference from Socorro
Robert Laing (ESO)
David Silva (ESO)

Apologies

Andrew Blain (Caltech)

Appendix C: Agenda for the ASAC Meeting of February 24-25, 2005 in Garching

24 February 2005

9:00 am 1. Organization and IPT liaisons (Closed session) (Turner, Testi)
9:15 am 2. Project status report (Tarenghi, Beasley)
Reading Materials:
ALMA Project Plan V2.0
ALMA Bilateral Agreement
JAO Positions Project Scientist Advertisement

10:00 am Discussion
10:30 am Break
10:45 pm 3. Report from Japan (Kawabe)
- ALMA Progress in Japan
- ACA
- Japanese procurement

Reading materials:
ACA Project Book

11:15 pm Discussion
11:30 am 4. Re-baselining options and Antenna Status (Beasley)
-Bilateral partners procurement

12:30 pm Lunch
13:30 pm Video connection to Mardones in Chile and Holdaway in Tucson.

Charge 1 Discussion

Reading materials Holdaway Memo of September 2004.
Second Draft, Feb 2005 Holdaway Memo.
DRSP
Extract from ALMA Science Requirements justifying ALMA's plan for 64 antennas.
ALMA Science by receiver band graph of sensitivity
Collected comments from ASAC and ANASAC members in the discussion wiki.

14:30 pm Discussion
15:00 pm Break
15:30 pm Discussion continues
17:00 pm ALMA Board Telecon (participants in this telecon leave)
18:00 pm Break for Dinner

25 February 2005

9:00 am 2. Charge 2 Discussion
10:30 am 4. Outreach (Project Scientists)
  - ALMA/NA Town Meeting at AAS; ANASAC (Carilli)
  - ESAC Meeting Report (van Dishoeck)
  - EU ARC (Wilson)
  - NA ARC (Wootten)
  - JP ARC (Kawabe)
  - ALMA science meeting (2006) Notes from Carilli Notes from Cernicharo (Carilli)
  - Discussion of ARCs (vanden Bout, Wilson, Wootten, Kawabe)

Reading Materials:
  Material from Feb'05 EU meeting
  Material from AAS NA meeting

10:45 am Discussion
11:00 am Break
11:15 am Science IPT Review (Wootten, Wilson, Kawabe)
11:30 am AIVC Report (Laing, Murowinski, Silva)
12:00 pm Discussion all items
13:00 pm Lunch
14:00 pm Drafting of report (Closed Session)
15:15pm Presentation of Findings (All)
15:45 pm Adjourn

Appendix D: ASAC Rules of Procedure

1. The ASAC is an advisory body, and its decisions are to be reached by consensus, so complicated voting rules are not required.

2. No quorum is necessary for the meeting to be deemed 'official' but it must be approved of and chaired by either Chair or Vice-Chair. If neither of these can chair the meeting, the members present shall nominate an acting chair.

3. Decisions shall be by consensus, on motion put by Chair

4. Dissenting opinions shall be recorded.

5. Any item can be added to agenda at any time by consensus of committee.