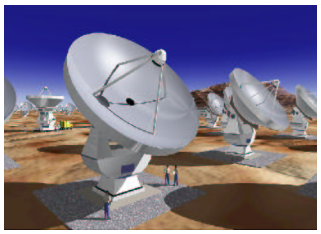

# ALMA Science Operations Questionnaire

## Response from the Community

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## A. Astronomer Interface Issues

### 1. Science Support

#### 1.1. What is your opinion on the RSC concept?

***ANSWER Walmsley*:**
The RSC would certainly be an extremely useful adjunct to the facilities available in Santiago. This will in particular be true if there in practise is just a "bare bones" ALMA staff available in Santiago.

***ANSWER Baker:***
It is essential for efficient use of ALMA that both the North American and European partners have support of proposals, data archiving, and data reduction available in their own time zones. I am generally in favor of the RSC concept. However, it is important to keep in mind that existing successful models (notably, the VLA and the IRAM PdBI) have benefitted from having the support astronomers be in close contact with operations at the site. This will not be the case for ALMA, which I think is potentially a source of problems.

***ANSWER Baudry:***
The main goals of the RSC should be to efficiently help the European users (technical preparation of proposals, data reduction etc.) but also to facilitate the access of a wide community

of non-specialists to ALMA observations. In addition archiving is essential with such a big project: to maximize the science return and to extract new results from the archive.
The RSC must help in broadening and unifying the European community behind ALMA.

***ANSWER Testi:***
An European RSC is certainly needed. It should be concentrated in one place, the preferred option would be ESO. Development of tools can be delocalizzated (as long as an appropriate managment/development plan is devised), but support should be centralized.

***ANSWER Ossenkopf:***
Good and essential, it is very important to have a contact address, giving unbureau support in Europe.

***ANSWER Fuller:***
An absolutely necessary and essential means of supporting users.

***ANSWER Papadopoulos:***
It is a good idea, along with a "node" European RSC

***ANSWER Diamond:***
My view is well known by now. I believe firmly and absolutely that Europe needs an RSC. I have laid out all of the arguments in my presentation at the ALMA Science OPS meeting.

***ANSWER van der Tak:***
If ALMA is to be used by non-experts, RSCs will be essential.

***ANSWER Andreani:***
Could you please FIRST explain what is RSC ???? this acronymous is not found even in ALMA web pages!

***ANSWER Tilanus:***
I believe that the RSC concept is a corner-stone development for the success of ALMA. There needs to be a strong ALMA presence in Europe as a focal point and support institute for European astronomers and university departments. A telescope as versatile and challenging as ALMA will deliver complex data subject to complex systematic problems needing a complex software suite.

Individual observers must have easy access to an 'expert' institute with the required infra-structure in place to serve their needs, in particular in cases that their home institute is lacking in that respect, a situation which probably will be fairly commonduring the early years of ALMA. Similar, a RSC can support university departments in their maintenance of the ALMA related infra-structure. These functions need an European based RSC.

Also, the concentration of expertise at a RSC will stimulate further development of the facility.

***ANSWER Cernicharo:***
Still diffuse to me

***ANSWER Giard:***
This has really to be understood as an operational project. There are certainly many different way to do it. This should be managed as a project, trying to find the best compromise between the needs and the will of the contributors.

***ANSWER Freudling:***
I think an European RSC is absolutely necessary. The most important purpose of such a center is to develope and maintain the expertise to calibrate, analyze use the data. In other words, tasks like Phase 2 prepratation, software developement, etc are important and can be organised in a variety of ways. But the most important product is the exepertese gained by people doing it.

***ANSWER Pierini:***
I find the RSC concept a very useful one. In particular the RSCs should reduce the distance of the ALMA array (in terms of observational and data-reduction techniques, science, inspiration of feasible projects) from the framework of the potential common users of ALMA who live in a given macroscopic region.

***ANSWER Fuente:***
In my opinion, it is necessary a RSC in Europe. It would give support to ALMA users and help them to take full advantage of the ALMA capabilities. In addition, it would also be important to increase the experience in interferometry of the european community and form young astronomers.

The RSC should be also an important site for software and (why not?) hardware developement for the ALMA project. This is important to improve the european capability on software and hardware developement. This capability could be important for our participation in future projects (after ALMA?).

***ANSWER Pety:***
It is a good idea for the following reasons: i) European scientists won't have to travel very far to have support for their projects and ii) this helps diffuse expertise to the community (i.e. more students and post-doc are likely to spend large chunks of time in the RSC if it is close to their home institution). I see one drawback: the fact that those centers are regional will not help cooperation with scientists of other continents.

***ANSWER Torrelles:***
This is a very important and crucial aspect for the successful of the project. It is essential. I think users need to have physical access to that kind of center for:
(1) sharing their knowledge about the instrument, (2) consulting with experts in instrumentation, (3) learning about software and techniques, and (4) training.

I have a high experience using radio interferometers like the Very Large Array and the Very Long Baseline Array since 1980. Even with my experience in these instruments I try to visit every year the Array Operation Center of the National Radio Astronomy Observatory in Socorro, to talk with people for learning new techniques about these instruments and data reduction. Without these periodic visits to NRAO my knowledge of these instruments would be much less competitive than now. This is why I think a competitive RSC is needed for ALMA.

In my opinion, there is a center in Europe with a high experience to play an important role in the RSC. This is Jodrell Bank. I cant see in the European environment other observatory with such a high experience supporting radio interferometry. This observatory should certainly play an important role for proposal assistance, imaging and analysis, archive data management, and training.

***ANSWER Gueth:***
I do think that a european RSC is needed for ALMA. There is no example of any large successful astronomical instrument that has no support center (or an equivalent structure). The fact that ALMA is to be used by all astronomers -without previous knowledge of mm astronomy techniques- is a strong additional argument to make sure that an efficient support is provided by the project.

***ANSWER Jacq:***
The RSC has to be a valuable place (virtual or not) to come or to contact for any kind of users, novice or experimented. Users should find there usable answers to most common questions. One should so find here good access to help, human help, knowledege database (FAQ, documentation, models, proposals handling system, archive,etc...). That implies a GOOD and EASY to use WEB site. The RSC should help a community to structure itself using various actions like schools, letters, etc..

***ANSWER Afonso:***
I believe the Regional Support Center is a very useful (and needed) structure for ALMA. Different models can be discussed, but I believe some kind of centralised institute which can provide (advanced) support to ALMA users (observation preparation, data reduction, organizing schools and meetings) is fundamental for its success (examples from radio interferometry - VLA, MERLIN, ATCA - or space observatories - ISO and, to a certain point, HST - clearly show this).

***ANSWER Tofani:***
Important/crucial structure of the ALMA project. Need full control by ESO, in any case fully transparent to the ALMA community

***ANSWER Martin-Pintado:***
I think that the concept of RSC has the potential to guarantee an efficient scientific exploitation of ALMA. Obviously the RSCs should be funded at the appropriate level. The present scheme of funding ESO+national contributions needs to be discussed to assure that the ESO funding rally covers the fundamental core functions and support provided by the RSCs.

***ANSWER Roelfsema:***
I do appreciate the idea of an RSC, but my worry is on how to get the proper size scale in place to 1) actually be a support center while 2)still be interesting for any group to set up. To me these two items seem to be conflicting in the sense that one of the main reasons groups areinterested in setting up a user support center need a payoff. The payoff in this case is money from ESO which likely will be interpreted as 'our institute gets bigger' while people often forget that the workload of such a RSC is BIGGER than the amount of money provided by ESO. It shouldbe made very clear that the payoff is NOT money from ESO, but an increased visibility of the institue, and that the institute actually pays for this as well; the hosting institute has to provide EXTRA manpower, i.e. it gets poorer, not richer. As a conclusion of this Istill agree with the concept of having an RSC I think it would be most effectively implemented by an organization that already is a service organization itself... i.e. ESO comes to mind. Note that this feeling may well be due to my 'space bias'.

***ANSWER Guelin:***
Millimeter-wave interferometry is often perceived as a complex observing technique and has so far attracted only a limited number of astronomers. It is therefore very important to open as soon as possible regional ALMA Support Centers that will help astronomers to get acquainted to this technique and be able to assess the robustness of processed observational results.

***ANSWER van der Hulst:***
To serve a large community of non-synthesis experts it is important to have systematic support from a group that is involved in alma on a daily basis.

***ANSWER Warmels:***
I believe we certainly need one or more RSCs. Certainly in the beginning ALMA observing experience is not overwhelming and the software will be far from complete (I'm realistic here). Both for the unexperience astronomers and well as for the S/W developers an effective interface will be needed to pass/exchange knowledge and to develop the ALMA Observatory and its operations toward a stable and mature state.

***ANSWER Dutrey:***
It seems to me necessary to have a RSC which works in close connection with chilean operating center and with the institutes. Its role is fundamental with respect to: expertise, software development and training.

## 1.2 European RSC

ESO intends to take charge (at least) of Phase 1 and of the archiving of the data. For the

additional RSC tasks (Phase 2 preparation, support on data reduction, any other tasks), various possibilities are under consideration.

**Which model do you favor for the European RSC?**

i. a true center at a single location
ii. a strong central node with a network of institutes
iii. two or three centers each specialized in some tasks
iv. a fully delocalized "virtual" center
v. others (please specify)

***ANSWER Walmsley:***
A true center at a single location

***ANSWER Baker:***
ii would be my preference. Support functions should be at a single central node. Software development and outreach efforts can in principle be more distributed. I'm not sure how archiving (at ESO) can be decoupled from data reduction (at the RSC).

***ANSWER Baudry:***
I tend to prefer ii above whereas cases iii and iv do not serve well the European 'integration' for wide use of ALMA. Case i is too far I believe from the European reality.
A strong central node with a network of institutes certainly means good organization: for example designate an institute and names of persons to help in a given area. The idea of a network also helps maintaining some internal European competition.

***ANSWER Testi:***
i (true center at single location)

***ANSWER Ossenkopf:***
ii. There should be one central place but at each institute with a strong interest in ALMA and considerable contributions to ALMA there should be at least one person paid (at least half time) for RSC work to provide a local contact.

***ANSWER Fuller:***
I prefer i or ii.

I think iv would be an extremely poor model. I can think of no delocalized institutes or organizations which work well. First it is extremely hard for such an organization to make its presencefelt and second organisationally it is a difficult, time consuming and inefficient way to run and manage a structure.

If in option iii the idea is splitting the user support is someway, I think it would be a disaster. It would just sow confusion in the user community about who does what. If the community is confused they will just not bother. If has to be clear to the novice looking in where they go for help and they have to be confident that they will get the best help available.

***ANSWER Papadopoulos:***
ii

***ANSWER Diamond:***
A true centre at a single location

***ANSWER van der Tak:***
A delocalized center seems to fit the european situation best. a strong single node may be good to develop new software etc.

From the customer point of view the degree of concentration is irrelevant since one interacts with one or two RSC staff members. however, distributing the center over europe would decrease travel time and cost.
From the staff point of view, having a few others around helps to do the job well: they can answer short questions, exchange ALMA news, ... but there's no strong case for a big monolithic RSC here.
Ideally, RSC staff should spend part of their time on ALMA, and part on their own science. in a monolithic center, it is easy to be swamped in ALMA tasks, for lack of scientific input
Having RSC branches at many institutes will help to involve the astronomical community in ALMA, as it increases interaction. with one single center, ALMA may remain a faraway thing for many non-radio astronomers.

***ANSWER Andreani:***
ii. if I understand correctly what a RSC is.

***ANSWER Tilanus:***
ii

**ANSWER Cernicharo:**
i or ii

***ANSWER Freudling:***
i. a true center at a single location

**ANSWER Pierini:**
I favor a strong central node with a network of institutes.

***ANSWER Fuente:***
I would favor option ii. It is important to have a strong central node which give full support to ALMA users. A network of institutes is also desirable. It is convenient that the most frequent users of ALMA can prepare their proposals and analyze data without traveling every time to the central node.

In the (in my opinion desirable) case of a RSC which also developes software for the ALMA project, the institutes forming the network can also contribute to this developement and specialize in some more specific tasks.

***ANSWER Pety:***
ii

***ANSWER Torrelles:***
A true center at a single location/two or three centers each specialized in some tasks. I think that the institute(s) involved in such task should be involved before in the commissioning of major radio interferometers given the immense amount of work needed. We have to be conscious of the experience available in these tasks in Europe, especially in the cm-wave interferometry world.

***ANSWER Gueth:***
i. a true center at a single location
This model is very attrative because of its simplicity, both from the organizational
and from the user's perspective. Especially, it provides a well identified entry point in the ALMA support facility.

ii. a strong central node with a network of institutes
This model has the advantage of the previous one, but also offers the possibility to i) make sure that the expertise existing in european institutes is used for the ALMA project, and ii) diffuse the (future) ALMA expertise in all communities.

iii. two or three centers each specialized in some tasks

This may be an option, but it maximizes the chances to fail to provide an efficient support because of the organization complexity, the predictable ambiguities to precisely define the role of each center, the problems to gather a critical mass at each location, etc.

iv. a fully delocalized "virtual" center
Definitely no. This is equivalent to no RSC.

***ANSWER Jacq:***
option (ii) seems the most favorable in order to join the advantages of a centralized node and of some kind of proximity. It would make more complex the organisation of the RSC but could be more efficient if successful.
option (i) would be to "strict"
option (iii) would quite probably make it difficult to achieve the main goal on an RSC. One could even think that, as time increases, some center will naturally fill more or less this function.
option (iv) difficulty here would be for the organisation of the center itself. Is it it really achievable ?

***ANSWER Afonso:***
Option ii. seems to me the most appropriate (options iii. and then i., in this order also seem good). I would envisage one central location for the European RSC, responsible for some fundamental tasks (eg, advanced data reduction, interaction with the observers) while some other institutes would take charge of less "public" tasks (eg, instrument development, where only a very small number of users - and very specific ones - would go). Alternatively, different centers could be setup (option iii) each being in charge of issues related to each instrument, for example. That would allow users to go to a specific place for advanced data reduction on a given instrument.

***ANSWER Tofani:***
ii

***ANSWER Martin-Pintado:***
I will prefer the option III with two-three centres which will have some commonality, but also different specialized tasks. The common support and functions will be provided by any of the centres and should also be available for the other centres. Institutes could make contributions to the different centres based on their expertise and/or
scientific interest.

***ANSWER Roelfsema:***
ii.... with as direct second iv.

***ANSWER Guelin:***
model ii is the best as it may make use of all european expertise in interferometric data reduction and gather a critical number of people in a single location. This will allow unexpert ALMA users to have a single point of contact for all matters concerning proposal submission and data reduction.

***ANSWER van der Hulst:***
ii

**ANSWER Warmels:**
I would prefer option ii. Option i is to restrictive; Option iii will lead to logitical complications and competence issues. It will also be confusing for the users. iv might be an option once ALMA Operationsd and Support is in a mature state (beyond 2011)

***ANSWER Dutrey:***
Intersection of i+ii:
A TRUE CENTER AT A SINGLE LOCATION WHICH IS THE (STRONG) CENTRAL NODE WITH A NETWORK OF INSTITUTES. True center: means it is the (only) direct link with the chilean operating center. Central node: means it has very strong connections with user institutes.

***ANSWER Gerin:***
I prefer the second solution ii since it gives the most visibility, yet enables dialog with the community to provide

## Please comment on the degree of "concentration" that you prefer. Can you give examples of popular or unpopular models of support centers?

***ANSWER Walmsley:***
IRAM has in the past two decades been such a center for PdeB observations and this has worked well.

***ANSWER Baker:***
I view the VLA and the IRAM PdBI as successful models of support center (at least, in terms of the expertise of the people who work there). I think that the IRAM PdBI model should be revised for ALMA in one respect, namely that it should not be standard practice for PIs to have to travel to the RSC to reduce their data (since this leads to prohibitive travel costs). Instead, I would recommend either (a) distributed software which can be installed and operated at the PI's home institution (the NRAO/AIPS model), and/or (b) the facility for remote login and use of the ALMA database and data reduction software (the OVRO model). The expected size of ALMA datasets suggests a possible compromise between these two models: the RSC would provide software for image-plane analysis which PIs could use at their home institutes, but would only support [computing intensive] reduction of [enormous] UV datasets on dedicated fast machines of its own which would be accessed remotely. I realize that in the early stages of ALMA, PI visits to the RSC will be more important for both ALMA staff and the PIs themselves; I just don't see this as a long-term mode of operation.

*A**NSWER Baudry:***
IRAM has helped in the preparation of the observing programmes and in reducing interferometric data but a true data pipeline has never been built and this may have discouraged some people.
The help with the VLA when I used it was organized but I have not seen the equivalent of a Support Center.
Building a fully popular support center is difficult... and concentrating all skills in a same place seems difficult.

***ANSWER Testi:***
Deconcentration is always a waste of resources. It may be useful to use specific expertise in some centers for development of tools and techniques, but this will require careful managment planning.

***ANSWER Fuller:***
Popular: JIVE, HST, NRAO AOC, Merlin

Unpopular: UK Gemini user support group. Their function is unclear and they are clearly removed from the action and experience at thetelescope and in development. (OK I might be a little biased here as I just had a bad experience with Gemini as a whole in this last round of proposals.)

***ANSWER Papadopoulos:***
At least one can-do-it all European RSC that will have a constant pool of experts on all ALMA issues, along with RSC that can offer as wide or more specialized support depending on the local users. In terms of acquiring and maintaining a pool of experts both types of centers are important. In such a setup experts can relocate between RSCs in a flexible manner, important if one considers issues of family etc.

***ANSWER Diamond:***
I believe that the 'support' functions should all be at the centre. It is crucial that a critical mass of support scientists and other staff (computer systems managers, archive staff, admin etc) be

concentrated to provide users with the broad range of support needed. Both new and experienced users will require a centre from which to learn and 'top-up' their knowledge. It is possible that software support and development could be elsewhere or even distributed, although current models of distributed software systems in astronomy (e.g aips++) do not work well.

***ANSWER van der Tak:***
Existing centers are mostly i or ii and some work well while others do not. judging option iv is hard by lack of examples. the VLA center in Socorro and the IRAM center in Grenoble seem good role models, while the ISO support was a bit scattered.

Staffing the center will be more successful if it does not force people to move far away. This point favours a more delocalized RSC.

***ANSWER Andreani:***
Most should be done on the web.

***ANSWER Tilanus:***
I believe (i) or (ii) to be the preferred model for the RSC, with some preference for (ii). (iii) to (v) I regard as being very unfavorable, due to the dilution and duplication of effort and resources and the increased risk that the individual centers will fail to meet the requirements.

The choice between (i) or (ii) is mainly a political one since in practice the two models can evolve to be very similar. Whatever chosen, the RSC must be allowed to become a true 'centre of expertise' in order not to jeopardize its mission. A STRONG central node is an absolute minimum requirement. The concentration of expertise and resources is the most critical aspect of this. The model I prefer is one with the RSC as a strong central node supporting the (computer) infra-structure of sub-nodes at strategically chosen university departments throughout Europe.

A strong central concentration has the risk in that place evolving into the only place where data reduction etc. can be successfully carried out. A network has the risk of the central node remaining a place-holder only. Of these two risks, I consider the second one to be the more debilitating.

***ANSWER Cernicharo:***
All the european expertise in radiointerferometry in one real center, or a network coordinated by a strong node!!!

***ANSWER Freudling:***
As I mentioned above, I feel the most important aspect of a RSC is to provide an environment in which ALMA scientific and technological expertiese flourishes. For this I think a strong scietific team is needed which actively uses Alma. The more concentrated they are, the easier it is to have the critical mass for viable scientific group which is competeitve with other groups including those in the US. All users of Alma will benefit from the existence of such a group as a single point of contact. I do not see any advantage in diluting the scientific expertiese. I also believe that a less concentrated organisation of the RSC will need more stuff and other resources to achieve the same goals.

***ANSWER Pierini:***
The strong central node should guarantee that the job gets done and, thus, should have some kind of control on the people and functions of the RSC, wherever the given people and functions are located. In particular, it should guarantee that the know-how achieved does not get lost because of local budget problems. The network of institutes (less than 5) should solve the conflict between benefit for the astronomical community and standards of life for the people employed by the RSC.

***ANSWER Fuente:***
I am a frequent user of the IRAM PdBI interferometer. It is very uncomfortable to go everytime to Grenoble to calibrate data, even for a very simple project. The software of data calibration is

always changing. From one project to another, something in the software has changed and you need specialized help to calibrate your data.

***ANSWER Pety:***
The RSC should be the entry point of ALMA to the European community. It will be much easier for users if there is only one well-defined entry point than a virtual network or even two or three centers. Also the bigger the number of RSC people working at the same location, the better because this eases the discussions between RSC staff. Moreover, the RSC should also have a good understanding of the software it uses. This is the only way to quickly correct bugs (when visitors are at the RSC for only a few days). In Europe, to make a good use of the spread experience, science softwares should however be developped where the expertise is. This probably precludes that all the science softwares being developped in a single place but then again there should be a strong center to ensure that all the parts fit well together. The best RSC model thus seems to be a strong central node doing the core activities of the RSC with a network of institutes delivering science softwares.

***ANSWER Torrelles:***
Examples of popular and successful support centers in the radio interferometry field are the AOC (NRAO, USA) and Jodrell Bank (UK)

***ANSWER Gueth:***
It seems to me that all existing support centers are built on model (i), with the exception of ISO (model (iii): one support center for each instrument on board). Whether they are successful or not is more a question of having an efficient organization as well as precise definitions of the roles of the various actors (agency vs center vs institutes).

***ANSWER Jacq:***
none

***ANSWER Afonso:***
Please see above. Some decentralised model seems to be the best. For ISO, for example, while there is one central institute for archiving and data reduction issues (the ISO Data Center) one can also go to the centers responsible for the different instruments if the need appears (for specific data reduction packages, for example). The more centralised approach used with radio interferometry (one center of expertise for observatories like the ATCA or VLA, for example) is also very useful (and popular).

***ANSWER Tofani:***
no answer

***ANSWER Martin-Pintado:***
I think one can find good and bad examples of any kind of support canters. For instance, as an occasional user of the VLA, I find that the kind of support you get from different institutions in the USA to prepare and reduce data is very good. Although, the scheme for the VLA is just one RSC at Socorro, in the last 10 years, everyone who has
experience with the VLA and AIPS can reduce relatively complex VLA data. Obviously, the VLA has been operational for more than 20 year, but this is the kind of support we should aim for ALMA from the beginning. The case of IRAM, is also a relatively highly condensed support centre. After more than 10 years of operation one needs to come to Grenoble to calibrate the interferometric data. The support in Grenoble is very
good, but the result is that the expertise in mm-interferometry has not spread out.
Although the comparison might not apply since space mission are limited in time, the Support Centres for the reduction of the ISO data were also concentrated in one or two places per instrument. The result was that many astronomers have to wait to reduce the data and it was quite difficult to do it at the beginning.

***ANSWER Roelfsema:***
One of the problems is that the actual way of working may change faster than our experience: 20

years ago all astronomers were happy with the pure concentration model - you do al the work at the telescope, and that is where all experienced people are - today that is almost unthinkable. Current (space) projects see very little visiting of people to telescopes/institutes, all interaction goes over the internet (proposal stage, observing specifications, data and analysis software). At the same time people get lots of specialized knowledge through electronic information exchange. Given the fast development in internet connectivity, I think that by 2010 people will find it absurd to travel around to a center, because that center is visible fromtheir desktop. This is the reason why a fully de-localized center may actually be the best solution.

***ANSWER Guelin:***
A high degree of concentration (at least half of the total staff) with a participation of people from the network institutes staying in the Central node for reasonably long periods of time (several months to 1-2 years).

The Central Node staff (which should consist of permanent members, plus rotating members coming from the network institutes) should gather expertise on all the facettes of data calibration and analysis; it should, in particular, have people actively participating in the development of the ALMA data reduction software; it should also have experts on data archives and archive interoperability.

The IRAM support Center is somewhat between model i) and ii). The Central node is located in Grenoble and provides to the visiting astronomers assistance in the reduction of their data (with the help of "local contact" astronomers). The Central node, in addition, distributes, upgraded software packages to a number of "correspondents" located in various institutes (MPIfR, Obs Paris, Obs Bordeaux, etc...) who take the charge of installing and maintaining the software in these secondary nodes. Astronomers of these institutes already acquainted with interferometric data reduction can reprocess their data directly from these nodes. The system is globally successful, but hampered by a too limited staff at the Grenoble node and too few correspondents.

Another model of support Center was the ISO support center which was close to model iii). My experience is that it was difficult to use for non experts (e.g. detailed information on the ISOPHOT observing modes and perforamnces was not really available at the ESTEC Center where we were suppose to prepare the observations).

***ANSWER van der Hulst:***
One could look at JIVE or the ATNF for a working model

***ANSWER Warmels:***
A strong center of knowledge would be able to provide support for most user issues. In my view too much distribution would lead to a loss of efficiency. Also, the RSC will need connections will the other european institutes, in particular with those where hardware/softare development is done and other area of competence/knowledge. Therefore a network will affiliated institutions is needed as well. However from the user perspective one single centre make things much clearer.

***ANSWER Dutrey:***
My answer is based on my experience with IRAM as internal astronomer (9 years) then as external member. IRAM has succeeded to provide efficient help at Grenoble for data reduction but it failed to train enough post-doscs and scientists as experts mainly because people are staying too long time in this institute and do not transmit their own experience to younger people by going in another place.
Having a strong RCS is necessary for the success of ALMA but the RSC will also have to train postdocs and scientists from the network. Moreover, it is important to guarantee that there is always the critical mass of experts at the RCS. I suggest that scientist at the RCS should not stay there more than 5-6 years in order to always have enougth young but already recognized scientists (35-45 years old). This is particularly important with ALMA because this instrument will be in use for more than 20 years.

## 1.3. Which functions and/or type of support would you like to have available at the European RSC?

***ANSWER Walmsley:***
It is extremely useful to have a "friend" available for each project in order that there is someone to whom an observer can address questions concerning the data reduction.

***ANSWER Baker:***
Support astronomers who can (a) provide information for the Phase 1 and Phase 2 proposals (b) provide help with data reduction questions would be the most important. Also, an archive with search functionality (so one can see which projects have been previously observed) and the maintenance of an efficient and stable data reduction package would be extremely valuable.

***ANSWER Baudry:***
Functions as mentioned above: help in proposal preparation and data reduction, archiving, advanced post processing. One must add construction and evolution/maintenance of the ALMA data pipeline. We also must attract people and the non-specialists:

- an efficient pipeline is a good way to maintain interest in the community of both expert and novice users
- one should have an easy access to what ALMA can do for you; simulators of observations might be an essential tool.
- basic training in interferometry (schools, tutorial exercises etc.)

A number of existing European institutes can help and share in these tasks.

***ANSWER Testi:***
Support for Phase I and II, support for data reduction and analysis, archive activities. SW development.

***ANSWER Ossenkopf:***
Proposal handling and support for proposal submission, support of astronomers in standard data reduction for ALMA, development, testing of data analysis software use of these tools in cooperation with scientists from the community.

***ANSWER Fuller:***
Cradle to grave support. (OK, sorry wrong analogy there). User support from science concept to publishing the result. To really draw in the non-expert community I think the RSC has to offer support to people would want to know the mass of material in their galaxies, but have no idea which molecule to observer never mind what the redshifted frequency is and which band it falls into. At the other extreme it also has to provide support for the expert user pushing the limits of the instrument.

I think one issue that may not be well appreciated is the need to have support as close to the end user as possible. In a machine as complex as ALMA certain subtle problems are only going to show up in the very last phases of data analysis. A startling example of this is the VLA HI pancake result, but there are plenty of other, less visible, ones too.

So activities for a RSC: 1) support for users with a full range of expertise including proposal design and Phase II preparation plus post-observing support, 2) monitoring data and instrument quality at a higher level and long timescale that the operations centre in Chile through interaction with the end users, 3) development and improved of algorithms and their software implementation, 4) outreach and community education.

An important issue about point 3) is that many of these developments are really going to be driven by the needs of the end users and so direct and immediate interaction with them is going to be vital.

***ANSWER Papadopoulos:***
All those necessary to be a successful user of ALMA in all its modes of operations.

***ANSWER Diamond:***
Advice on proposal prearation
Phase 2 proposal assistance
Archive mirror and data distribution
Data reduction support
Software support/development - although see above.
Running of schools etc
Education and public outreach - ALMA will need a physical centre.

***ANSWER van der Tak:***
For myself, only answers to occasional questions would do, after an introductory tour through the software package.

In general, the job of the RSC is to balance the effort of obtaining ALMA data with the scientific reward. An example of imbalance is VLBI, where one spends so much time reducing data that (often) little time is left to do science with them.

***ANSWER Andreani:***
Instrument Scientists, Calibration Scientists, Data Reduction

***ANSWER Tilanus:***
- access to data
- calibration information
- meta-data: full instrumental history such as efficiencies, problems, etc.
- data reduction facilities
- access to experts
- active support for the development of innovative techniques and reduction software.

***ANSWER Cernicharo:***
What I consider as absolutely necessary is a good coordination of the available expertise as soon as possible to ensure a scientific use of ALMA in 2012 and not several years later. How the instrument will be used by the scientist, and who will help us with the data reduction is for me a second plane problem compared with the one related to who and how will put ALMA in operation. While ESO is a real node of expertise in optical and infrared telescopes and instrumentation, the radioastronomical community is rather disperse without a clear center to coordinate the "know how" in radioastronomy. In addition, we have many different european groups, with their own = interests, and poorly organised to put ALMA in operation.

***ANSWER Freudling:***
The most important aspect for me is that I want to be able to talk to true experts which have hands-on experience and who can provide sound scientific judgement.

***ANSWER Pierini:***
I would like to have a European RSC capable of providing the astronomer interested in the scientific potential of ALMA with the know-how required for understanding the best observational strategy suitable to achieve a given goal, writing a succesful proposal (beyond the eventual tools available in electronic format) and reducing the data at best (also in the case of archive data). In addition, it should be at least a mirror archive and it should offer education on submm and mm observational techniques for young and senior scientists.

***ANSWER Fuente:***
Phase I: It would be desirable to have someone to help in the design of the observing strategy. The best thing would be that the technical evaluation of the project were previous to the proposal submission. Then the proposers could correct the observing strategy and submit a feasible and

technically well-design proposal. The programme committee would only have to evaluate the scientific merit.

Phase II: Since ALMA is a unique instrument, it is important to guarantee the quality of the published data. An error would be fatal. Something like a "quality control" is necessary

***ANSWER Pety:***
Knowledge about the instrument to better prepare proposals.
Knowledge about the software to help data reduction.
Knowledge about astrophysical problems as it is always easier to solve a reduction problem if the staff astronomer also understands the observation goal (this is not mandatory, this is just easier).

***ANSWER Torrelles:***
Proposal assistance, software development, training, imaging and analysis, and archive data.

***ANSWER Gueth:***
I imagine that the RSC should at least

- host a copy of the ALMA archive
- provide support before the observations
- provide support after the observations (data reduction)
- provide support for eg large key programs
- organize formation activities
- be involved in R&D development on eg data reduction techniques.

I think it is very important not to break the continuity that exists between the technical (software) developments, the support to the users, and the actual science.

***ANSWER Jacq:***
All of above goals. help in proposal handling. help in understanding the various capabilities of ALMA. An efficient simulator.

***ANSWER Afonso:***
Essentially, all aspects of data reduction, possibly at an advanced stage (the basic data reduction could be included in the data products, for example, but if one needs to explore/improve data reduction, one would do it at the RSC). Access to the data archive and proposal preparation are also things I would expect to see at a RSC.

***ANSWER Tofani:***
Data archiving, simulations and any other task needed to prepare observations. To be discussed which impact the RSC has to have on the future ALMA developments. Is it the site for future technical developments?

***ANSWER Martin-Pintado:***
I think that the support one gets for the VLA at Socorro could
serve as a guideline.

- Support to prepare all kind of observations (proposals) even the difficult ones which push the interferometer to its limits.
- Support for data reduction including the combination of interferometer and single dish data. The RSC should provide standard products like images and uv tables obtained with standard pipelines.
- Database archiving, handling, maintenance and access.

***ANSWER Roelfsema:***
Most importantly deep instrument understanding

***ANSWER Guelin:***
the central node should be charged of:

- software development (for the data calibration, archiving, pipeline and off-line data reduction),

- data archive maintenance,
- full assistance to users (preparation of observations, data reduction, data interpretation, data quality assessment, access to the alma archive and to archives of complementary data at different wavelengths),
- feedback of problems/requirements to the project.

The institutes participating to the network would provide more limited support to local astronomers (installation and updating of software for off-line data reduction and presentation, help in accessing the data archives) and could be involved in some specific software development tasks. they would share with the central node the organisation of schools and workshops.

***ANSWER van der Hulst:***
Proposal writing support (time estimators, alma performance documentation), reduction and analysis support (at various levels from beginner (probably most important) to expert), archival access.

***ANSWER Warmels:***
I believe we should make a clear split between ALMA Operations (Chile) and ALMA Support (US/EU). Until the Scheduling Blocks have been defined and put into the scheduling system, the RSC should be responsible for the support and the contacts witht the astronomers. In praktice this means Phase I and Phase II fall under the RCS responibilities. Data Reduction is a post observing/operations activity and as such this should fall under the RSC.

ALMA Operations in Chile will take responsibility as soon as the SBs are in the system and activite. They deliver the product. In my view User support provided by Chile should be kept to a minimum. In this sence I would prefer a model which is similar to the VLT Operations and Support model.

Other issues/Responsibilities to be discussed and to be decided upon include:
- Contact to astronomer during the observations (break points, quality control, etc)
- Quality control
- Trend analysis
- Data distribution
- Archiving
-

***ANSWER Dutrey:***
- ALMA data expertise (in term of quality check, optimization of observational methods, data reduction process)
- Software development/improvement (data reduction and image analysis tools)
- Training of postdocs and young astronomers - Around 2/3 of the staff should be post-docs or young scientists with position for 3 years. As a reasonable rule, people should not stay at RCS more than 6 years.

***ANSWER Gerin:***
All basic functions described in the talk The European RSC must be also a center of excellence for asronomical research.

## 2. User Software

### 2.1. Are the ALMA software goals sensible? Are any desireable features lacking?

***ANSWER Walmsley:***
None that I foresee presently. Unfortunately, most of these "desirable features" we will only learn about once things get going.

***ANSWER Baker:***
My impression is that the goals for the data processing package are reasonable (I am more concerned about whether they can be achieved using AIPS++ as a foundation). I am extremely skeptical that the goals stated for the scheduling and observing software (e.g., with break points, automated dynamical scheduling, etc.) can be achieved at any level in the first few years of operation. I would suggest that these second-order options only be offered to the user community in 2011 *at the earliest*, and that the present work on software development concentrate on the pipeline and on the most basic level of array operations and data flow.

***ANSWER Baudry:***
I am not in a position to answer

***ANSWER Testi:***
Goals are ambitious but sensible. Clear plan for off-line data processing is missing (see below)

***ANSWER Ossenkopf:***
Sensible - yes. For missing features one should check the list against the "End User requirements for HIFI interactive analysis". I did not spend the time for this full comparison.

***ANSWER Fuller:***
Yes the goals are sensible. The science archive has a low priority and should be better funded. It is as yet unclear where desirable features are missing.

***ANSWER Papadopoulos:***
I am not fully informed on this to give an answer

***ANSWER Diamond:***
Basic goals appear to be sensible but the attitude I see amongst some ALMA staff/associates is that the software will be 'so good' that users support need only be minimal. Many painful years of experience suggest that you plan for the worst and be relieved when that doesn't happen. Realism has to be the watchword.

***ANSWER van der Tak:***
The principal product of ALMA will be calibrated uv data, and the software will only be for imaging. the excellent uv coverage of ALMA will make the imaging much less dependent on choice of weighting scheme and deconvolution method than it is with existing mm interferometers.

Is there a summary of the requirements around? memo 11 of the software group is a very detailed 150-page document...

***ANSWER Tilanus:***
I believe that full data simulation is a laudable goal, but I am worried about the effort it will take away from the direct development of data reduction and instrumental support. I am not sure that the majority of the 'standard' observations will benefit much once the initial few simulations have been run. In summary: I am concerned about the cost-benefit of this exercise.

I am concerned about an attitude that the ALMA 'pipeline' reduction will provide the 'final' answer and that, consequently, not enough thought is given to allow the pipeline to be flexible, user

configurable, and to be run at any location such as a university department. In contrast too much effort may be spend on automating (pipelining) reduction steps which should remain hands-on steps for the investigator.

The software goals should be:

- ALMA will produce representative pre-view images allowing a reliable evaluation of the data quality.
- ALMA will provide a software suite necessary for the full eduction of its data that can be installed at any institute with the available infra-structure.
- In addition to above software ALMA will provide a pipeline for a default reduction of data, but one which is user-friendly and configurable. This pipeline will aim at, but not guarantee publication ready data.

I.e. the main goal of the reduction software effort should be to produce a practical but flexible product for the community and which thus will also full-fill its role at the telescope rather than the other way around. In my perception there is a real danger of a complex software product which will turn out to be quite impractical for the user in general.

***ANSWER Cernicharo:***
I think ALMA deserves a specific software rather than adopting an existing package !!

***ANSWER Giard:***
No opinion on this subject except same as previous.

***ANSWER Freudling:***
I doubt that it is possible to use Alma as a "camera" without any knowledge of interferometry. I think it is important to have a two stage approach to software. First and most importantly, provide software which can be used by users who know or are willing to learn about interferometry. The more ambitious goal of a "camera mode" should come later.

***ANSWER Pierini:***
I think that a special care should be payed not only to develop a pipeline for the preliminary reduction of the data, consistent with the baseline software environment, but also tools (available on line) for planning the observations with ALMA at best. As an example, I quote a display with the simulated coverage of the UV plane and visibility function for a given planned observation.

***ANSWER Fuente:***
The ALMA software goals are quite ambitious.

From the point of view of a potential user, it is important to get a final and users friendly (without bugs) package. It is very difficult to work with packages which are being continuously updated. A good and complete documentation is also desirable.

***ANSWER Pety:***
That's a very large issue. I will speak here only about the reduction softwares with which all astronomers using ALMA will have to deal with and in particular the pipeline. Let me first dream to what should be the scientific softwares of ALMA based on my current experience:

- I first want to retrieve the default reduction made by the Science pipeline in the following forms:
    - Data cube.
    - Main numbers describing the quality of the data (noise, seeing, resolution).
    - Reports of the data reduction with all decisions taken by the Science pipeline and curves summarizing the calibration.

  Hence I know potential problem
- Then I want to quickly look at the data in a very interactive way through a data visualization packages. This way I know whether there is something potentially interesting in my data. Here

either I think there are no potential problems in the pipeline data reduction and I am finished or I think there are potential reduction problems.

- There is something potentially interesting in the data but there may be some reduction problems. As I know all the decision taken in the pipeline, I want to rerun it forcing some of the decisions to correct the problem. Then I iterate the process up to the point I am satisfied with the result.

I think this is more or less what are the goals in the SSR document. From a computing point of view, there must be three elements:

- A data visualization package with the following capabilities:
    - A highly interactive presentation of data cubes which understands that all the 3 directions are not equivalents (i.e. we deal with spectro-images).
        - This should allow the user to easily do at least everything available in current packages: general 1D-cuts, position-velocity diagram, spectra maps, mean spectrum computed on a user-defined support, computation of higher order moments.
        - The possibility to make the same interactive operations on more than one cube at a time as we more and more want to compare the same object in different lines or with
        - continuum.
        - The possibility to save in a standard binary format every interactively extracted object (mean spectrum, cuts, higher order moments) for futher processing in other packages (i.e. fit, comparison with models).
    - A highly interactive presentation of the properties of UV visibilities: uv coverage, amplitude and/or weight versus uv distance, azimuthal averaged, etc...
    - The possibility to have a printed plot for memory or publication of all the possibilities offered by the interactive visualization.
    - The possibility to very quickly be able to write a script to redo the same figures but not interactively. This is i) to keep memory of how you obtain the the figure and ii) to be able to build complex figures made of "simple" elements for the same data set.

  Maybe there exists such a visualization tool but I do not know it. Some come quite close in term of understanding the particular kind of data we deal with but there are not interactive enough.

- An intuitive user interface which would be the interface of an interactive pipeline (i.e. you use the same procedures as the pipeline but you enforce some decisions). This implies the following capabilities:
    - Ordered display of the report of the last call to the pipeline.
    - Possibility to set some parameter to a desire value (e.g. Use this weight value or use MEM and not CLEAN).

  The report is here a mix of the decision taken by the pipeline (in particular the path followed by the pipeline) and of figures that summarize the results (as is done in PdBI reports for instance). To order this information, we could use something close to a file system browser (as the window explorer), each node of the tree being ordered in an intuive way (most important decision come first) and the figures associated to the pipeline path being automatically displayed as we progress.

- A pipeline tailored to take into account the possibility to be interactively rerun. There is much to say here, but this is more difficult to describe in a few lines because this is a lower level part of the software (i.e. probably the most important part to obtain a result but standard astronomer should not interact directly with the pipeline).

It is sensible to ask for all that. Now is it possible to have all that? This depends. The key to success is to well separate the different components with very well defined interfaces and to write (or choose those components) in a very focused way. They must be incredibly good in doing their job but they must do only their job. If this is not the choosen design, e.g. givint a central role to a

part (for instance the DRP, Data Reduction Package), this may work acceptably (this is the case of GILDAS, MIRIAD and others) but this is quite difficult to make that evolve. And if the DRP suffers itself from a wrong design this may lead to lot's of headaches. Even if we well separate the part, we probably have to set priorities (pipeline first, visualization tools and data reduction user interface second).

Finally, here is a little sketch of my view of the ALMA scientific softwares:

```
Data Reduction User Interface (GUI and CLI) <=> Visualisation tool
                    ||
Pipeline heuristic (intelligent scripts
                    ||
Executor (take care of the hardware possibilities:
      ||      number of CPU, RAM memory, harddisk capacities
Data reduction package (collection of algorithms)
```

There should be only one entry point for data coming either from the archive or from a simulator. So there must be at least two others entities: the archive and the simulator. Between all those elements (Data Reduction User Interface, visualisation tool, pipeline heuristic, executor, data reduction package, simulator archive) there should be well defined interfaces that allows us to replace one of the elements independantly from others.

***ANSWER Torrelles:***
Yes, I think they are sensible.

***ANSWER Gueth:***
I think that the goals are sensible, but very ambitious. I'm not sure that the requested manpower is available.

***ANSWER Jacq:***
none

***ANSWER Afonso:***
I think at this stage the software goals are sensible, although I expect the amount of data output from ALMA will stretch software capabilities to the fullest (advances in hardware over the next years will help to achieve the software goals).

***ANSWER Tofani:***
In my opinion the software strategy has still to be well defined. One has to expect several developments**.**

***ANSWER Martin-Pintado:***
I think the goals are sensible. Basically all the main features are included

***ANSWER Roelfsema:***
They appear sensible... I worry if they are reacheable..

***ANSWER Guelin:***
Goal of fully automatic pipeline may be too ambitious, at least at the beginning (when there will be only a relatively small number of antennas) and when the atmosphere is not very transparent (also near atmospheric lines or at high frequencies).

***ANSWER van der Hulst:***
The goals are very complete and geared toward the novice and non-expert user. I am afraid that pipeline processing will not be as easily implemented as envisaged. experience at existing synthesis telescopes shows that providing a useful pipeline product is very difficult. This is no reason not to try as software and software design gets faster and smarter all the time.

***ANSWER Warmels:***
I believe they are sensible, although I have some doubts with regard to the Observing Tool. From what I have understood there is a danger that the OT get overdimensioned and will be extremely heavy. I would prefer a Tool Box approch where the user can run the various software components seperately and possibly independently. Also I the believe we are too optimistic with regard to OT development. I think we need to define realistic schedules and priorities here and we need a better balance between available manpower and the goals.

***ANSWER Dutrey:***
YES - having a user friendly software is fundamental for the success of the project.

**2.2.AIPS++ is the baseline software environment for developing the ALMA data reduction pipeline and off-line packages. AIPS++ has been distributed to the community within the last 2 years, so any feedback on experience with this package is welcome.**

**2.2.1.Have you used AIPS++? If so, in what context (e.g. training at NRAO summer school, reduction of GBT data, ....) and what is your opinion of the package?**

***ANSWER Walmsley :***
No

***ANSWER Baker:***
I have not used AIPS++.

***ANSWER Baudry:***
No use of AIPS++

***ANSWER Testi:***
no

***ANSWER Ossenkopf:***
No

***ANSWER Fuller:***
Yes, for a large single dish mapping survey. It has a steep learning curve, but when it worked it was fine, but unfortunately there was a new release and we could no longer import our datasets into it.

COMMENT: I think we need to be a lot more careful about using the phrase AIPS++. It actually covers two separate things. First the base classes and definitions and low level routines and packages and second the high end user interface. These are essentially independent and we should be very careful not to confuse the two. The higher end user interfaces are very poor, with a steep learning curve, on the other hand I understand the libraries on which they are built are well designed. One option I would like to see explored is whether we can take the C++/AIPS++ libraries and replace GLISH which is used to glue them together with a much more standard scripting language such as Python.

***ANSWER Papadopoulos:***
No I have not.

***ANSWER Diamond:***
Yes, analysis of existing images. My opinion is that there are good ideas within aips++, excellent algorithms and the promise of a good future. However, the user interface is about the worst I

have ever encountered and is has problems (maybe not insurmountable) with spped.

***ANSWER van der Tak:***
Have not used it myself. people tell me that the concepts of aips++ are good, but their implementation still needs lots of work.

***ANSWER Tilanus:***
Unfortunately I have no expertise with AIPS++ yet although I expect to start using it within the next year for the reduction of single-dish data. Local staff training on AIPS++ is under development.

Having said this, the frame-work for the ALMA software should be transparent such that individual users can relatively easily incorporate custom reduction routines. In a way, this is the 'Open Source' vs. Windows issue revisited. The success of Linux in the university environment is a clear indication that an 'open source' frame-work will stimulate lots of development and contributions by the community.

***ANSWER Cernicharo:***
No

***ANSWER Freudling:***
no

***ANSWER Pierini:***
Unfortunately, I have never used AIPS++.

***ANSWER Fuente:***
No, I have never used AIPS++.

***ANSWER Pety:***
I am engaged in the test of adaptability of the AIPS++ package to reduce Plateau de Bure Interferometer (PdBI) data. There are good points (looking on the principle point of view) but they are linked to bad points (looking from the implementation point of view).

First, the good principles:
1. The measurement set model (i.e. not its implementation) has been thoroughly thought as a way to store data out of a telescope and an interferometer in particular. This is probably the best model today to store data. It is not complete for millimeter interferometry but it is easy to incorporate what is missing.
2. The measurement equation is an unified way of looking at the calibration of interferometric data. This is a pretty elegant formalism. However it has not yet been proved to successfully calibrate Plateau de Bure data (in fact, as of today it still fails at 1mm). Is it a formalism difficult to adapt to mm interferometric data? This issue should be studied more.
3. The possibility to make computation on values with an associate unit.

Second, the implementation problems:
1. There are too many layers between a command and the algorithm run by the command. This implies i) a serious loss of efficiency and ii) difficulties to maintain the software (i.e. in which layer this bug is located). In a DRP, proposed services should be straightforward.
2. Exception handling is not correct inside AIPS++. When there is a problem inside an algorithm (like a division by 0), this should be taken care of and not make the program collapsing or hanging around. From the IRAM test (which has a small scope compared to the ALMA pipeline), we have a number of examples where exceptions are not correctly handled and others where when exceptions are handled, the message is cryptic and it is difficult for new comer to understand what happened. The former category is very annoying for the pipeline in case the DRP is at the pipeline center. This is still a problem but less important if the pipeline infrastructure is not done outside the DRP. The latter category is very annoying for standard astronomers who do not want to search during hours why it is not working (i.e. is it a real bug or just a misuse due to lack of experience?).

3. The scripting language (glish) is something which is maintained only by AIPS++. This means that there is about one (at most a few) person in the world which maintains it. How can the capabilities of this scripting language compete with others like python that are developped and maintained by gifted professionnals all around the world? The fact that the scripting language is linking to the data reduction package comes from the time where there were no good alternative (indeed this is the case of GILDAS, IDL). But is it still a good model today? Young astronomers of tomorrow will be more willing to learn python that is used in lot's of place than glish that is used inside AIPS++.
4. AIPS++ is engaged into many projects at the same time. They must thus adapt AIPS++ to the special needs of each project/each telescope and there always are lot's of special needs. This is not a problem if 1) there is enough man power and 2) the architecture is well separated between the core tasks of the data reduction package and what is specific to the instrument. But this does not seem the case in AIPS++: 1) They always have difficulties to find time to work on the ALMA test (reduction of the PdBI data). This implies a limited man power. As they have to work to adapt the package to the instrument needs, they have no time anymore to work on the core functionnalities. 2) From the proposed design of the pipeline where it is thought to put all the knowledge of ALMA inside the DRP, I have difficulties to think that the core tasks are well separated (which means more than to be in separate directories). This is a main problem because if for the need of another project something in the core functionnalities are changed, it may make crash the functionnalities specific to the ALMA project. This is perhaps one of the reason why the ALMA test of AIPS++ seems unstable.
5. AIPS++ has been developped when object oriented programmation was still a new technology. Development methods (like UML used in the ALMA project) for object oriented programming are relatively new (less than 10 years old) and thus have not been used to develop AIPS++. AIPS++ is perhaps suffering from having made this technological choice before it was mature.
6. Last but not least, AIPS++ is not user-friendly. Interfaces are set up automatically from the underlying object definitions. This can not give user-friendly interfaces because the logic of the software design, which is reflected in the objects, is completely different of the logic of the new (or even experienced) users. We must not confuse the logic of the engine of a car with the ease of driving it!

***ANSWER Torrelles:***
No, at moment.

***ANSWER Gueth:***
I have been using AIPS++ for more than one year now in the context of the AIPS++/IRAM Plateau de Bure test. My general opinion on that package is for the time being negative. It is very surprising to me that, after more than 10 years of development (and an impressive number of FTEs), AIPS++ is still in an "under development" stage: it is instable, its use is not practical, the user interface quality is very weak, several key features (e.g. flagging, flexible vizualization tools) are missing, ... In addition, the learning curve for developments is quite slow.

It seems to me that the main origin of those problems is to be found in the complexity of the package. AIPS++ has been developed with a goal of high versatility: it should be used for most -if not all- radio telescopes, single dishes, interferometers, as well as VLBI, at all possible wavelengths, using the same formalism and core functions. The range of problematics to be covered is so large that a very complex infrastructure has been built. As a consequence, any simple problem is treated by a complex and heavy machinery. I have strong doubts as to the relevance of this approach. I'm inclined to think that the way to go is to pursue what has been done successfully with other data reduction packages, namely develop softwares tailored to a well-defined problem.

In addition, it is my personal prejudice to think that the AIPS++ team is trying to make too many developments simultaneously (technical changes, new algorithms, new instruments supported), with the results that none of them seems to converge. It is deeply surprising to me that, after so many years of development, AIPS++ is still not yet able to reduce VLA data with the same functionalities than AIPS!

***ANSWER Jacq:***
Never used it. Most comments were doubtful about its simplicity.

***ANSWER Afonso:***
No - just a brief look at the initial development phase.

***ANSWER Tofani:***
I have not direct experience. However we are involved in a project which includes the use of AIPS++ for single dish receiver array spectroscopy and preliminary evaluations seem positive

***ANSWER Martin-Pintado:***
NO

***ANSWER Roelfsema:***
No experience

***ANSWER Guelin:***
no, I have not personnally used AIPS++

***ANSWER van der Hulst:***
I have used the display package to produce publication ready figures. i have not reduced any of my synthesis data in aips++. Main reason is unwillingmess to invest the time to learn and the said poor performance.

***ANSWER Warmels:***
I have not used it.

***ANSWER Dutrey:***
I have seen several people at IRAM trying to use it. What I have seen has discouraged me to try it.

### 2.2.2.For those not using AIPS++, please indicate whether any of the following reasons apply:

i. Complexity in using it, tools missing, ....
ii. Learning curve too long
iii. Problems of documention
iv. Bugs
v. Needs currently satisfied in another software environment
vi. Lack of expertise and training in Europe
vii. Other (if so, please specify)

***ANSWER Walmsley :***
One only uses these things once one has to! Or in other word sloth ! I have always exploited others for these purposes and so I am not the person to ask.

***ANSWER Baker:***
I use MMA (OVRO calibration software), AIPS (Classic), GILDAS, and MIRIAD for reduction of my data from current millimeter interferometers. Among people I know who have tested AIPS++, no one has recommended that I switch over to it: it's buggy, inefficient, difficult, and poorly documented. According to the listing at http://aips2.nrao.edu/docs/gettingresults/swdictaips/swdictaips.html there are also a number of AIPS commands I use regularly which do not exist in AIPS++: DBCON, ISPEC, and UVFIT. I would therefore cite (i) through (v) in the above list.

***ANSWER Baudry:***
Reason v: all needs satisfied with CLIC (IRAM interferometer) and with AIPS (VLA and VLBA/EVN)

***ANSWER Testi:***
Tools missing, learning curve too long, too unstable, other better (faster, easier, more reliable, fully documented and functional) software available.

***ANSWER Ossenkopf:***
v and vi

***ANSWER Papadopoulos:***
v, vi

***ANSWER van der Tak:***
v.

***ANSWER Tilanus:***
v and vi

***ANSWER Cernicharo:***
i, ii, iv

***ANSWER Pierini:***
Needs currently satisfied in another software environment.

***ANSWER Pety:***
Just one more comment. For me, all apply, except v. No software environment (included AIPS++: the low level algorithms used to calibrate PdBI data inside AIPS++ have been copied verbatim inside AIPS++, ATM is not yet implemented inside AIPS++) currently satisfy the needs of ALMA. Even if we add all the algorithms available in the different packages, there will be stuff missings (like reduction of interferometric OTF mosacing but this is probably not the first priority of ALMA for early science). However, adding those algorithms make a very good start to fulfil ALMA needs. It is (just) a question of packaging.

***ANSWER Torrelles:***
Sometimes, age makes a frontier against learningnew software packages. This is certainly my case. But I hope that I as well as my students will use AIPS++ if this will be the ALMA software.

***ANSWER Gueth:***
i. Complexity in using it, tools missing, ....Using AIPS++ is very perturbing for a newcomer, because he/she has almost to understand the logics of the object-oriented code to be able to use the software. Obviously, it should be precisely the other way round: the software should match the user logics, and propose a number of functionalities organized around the main data processing steps. This is a strong call for a decent user interface.

ii. Learning curve too long
Learning curve to use a given AIPS++ tool is not so long. Learning curve to use several tools in a row in order to obtain some valuable result is certainly much longer, because of the numerous traps and bugs. Example: plotting the result of a deconvolution requires many actions (closing a window, opening new ones, answering several unrelated questions, finding the proper options in a very long menu, etc). This makes it very complex -if not impossible- to iterate between the deconvolution and the imaging steps.

iii. Problems of documention
No.

iv. Bugs

Yes. My experience with AIPS++ is that this package is nstable: numerous crashes are caused by all kind of minor reasons (typo in source name, progressmeter, etc), making a detailed analysis of the results -and thus a search for the real algorithmic bugs- difficult.

V. Needs currently satisfied in another software environment
Yes. All major radio-astronomical facilities have developed or are using a dedicated package, which fulfills all the needs. Switching to a new package is justified only if this new package gives access to new important attractive features - which is simply not the case for AIPS++.

vi. Lack of expertise and training in Europe
No.

***ANSWER Jacq:***
none

***ANSWER Afonso:***
v. For radio interferometry data, I have used MIRIAD.

***ANSWER Tofani:***
iii, ii, vi

***ANSWER Martin-Pintado:***
V. AIPS and Graphic did the job quite satisfactorily for my interferometric data.

***ANSWER Roelfsema:***
v.

***ANSWER Guelin:***
AIPS++ is not the standard package on any of the major radio interferometers (IRAM, BIMA, VLA, ...). It misses tools adapted to the calibration of mm-wave data, so that I can see no immediate advantage in getting trained and using this package for my own observations. I understand also that it is not straightforward to write personal macros in AIPS++, which makes difficult the reprocessing of data of projects extending over long periods of time.

***ANSWER van der Hulst:***
v, ii, i

***ANSWER Warmels:***
Not directly involved in science. Lack of time

***ANSWER Dutrey:***
i+ii+iv.
v: I am reducing interferometric data since 1991 (PdBI) and the GILDAS package is definitely more adapted to PdBI data and simple. AIPS++ is definitely too complex to be ``user friendly'' as ALMA would like to be (and must be)

***ANSER Gerin***:
vi

### 2.2.3.For those who develop software (methods, algorithms, needs for specific telescopes,...)
### i . Did you consider using AIPS++? If not, why?

***ANSWER Baker:***
N/A

***ANSWER Ossenkopf:***
No. Learning curve always favoured solutions close to to the existing packages. Installation of the whole AIPS++ system is non-trivial. Strong background in CLASS, IDL or Java in the different projects.

***ANSWER Fuller:***
Yes, because of the basic libraries.

***ANSWER Diamond:***
No. Learning curve for C++/object oriented too long. AIPS++ can only be programmed efficiently by the 'annointed priesthood'.

***ANSWER van der Tak:***
n/a

***ANSWER Tilanus:***
No yet: I am presently unfamiliar with AIPS++. From that point-of-view it appears daunting, both as a user and developer.

***ANSWER Cernicharo:***
No, I am a Fortran user

***ANSWER Pierini:***
N/A

***ANSWER Pety:***
Maybe I will have to use it a lot. But I am not happy with it.

***ANSWER Torrelles:***
I am planning to use it in the immediate future if AIPS++ will be the ALMA software.

***ANSWER Gueth:***
IRAM has its own dedicated package (GILDAS), which has a narrower scope than AIPS++, but is precisely tailored to the needs of the IRAM instruments and users. The argument that one should develop in AIPS++ because it is a modern platform that will be widely used in the future is kind of a self-predicting argument.

***ANSWER Jacq:***
none

***ANSWER Afonso:***
NA

***ANSWER Martin-Pintado:***
No, because all my VLA collaborators refused to use AIPS++

***ANSWER Roelfsema:***
Yes we are actively considering AIPS++ for (parts of) the Herschel HIFI data analysis environment.

***ANSWER Warmels:***
I considered but I didn't have the time yet, neither a reseach project to work on.

***ANSWER Dutrey:***
I do not for PdBI data reduction. For ALMA data, I believe that this software is too complex and not adapted to a general use by non experts. This is a REAL problem for ALMA.

### ii. Would you recommend using AIPS++ to your students or others?

***ANSWER Baker:***
*N/A*

***ANSWER Ossenkopf:***
not now, but simply due to the lack of experience

***ANSWER Fuller:***
Yes. Indeed one my students is using it and we are looking at the libraries for software development.

***ANSWER Diamond:***
For some applications. Currently, not for data calibration. But that is improving.

***ANSWER van der Tak:***
n/a

***ANSWER Tilanus:***
Yes, I would, simply because I believe it deserves a chance and that it may well be the way of the future. However, I am quite worried that it has not 'caught on' yet and am wondering about the underlying reasons for this.

***ANSWER Cernicharo:***
No at this moment

***ANSWER Pierini:***
N/A

***ANSWER Pety:***
No.

***ANSWER Torrelles:***
Yes, in particular if AIPS++ will be the ALMA software.

***ANSWER Gueth:***
No.

***ANSWER Jacq:***
none

***ANSWER Afonso:***
NA.

***ANSWER Tofani:***
yes we do in our Institute

***ANSWER Martin-Pintado:***
No, until a decision is made by the Europeans

***ANSWER Roelfsema:***
Yes - it is almost by definition THE radio analysis package for the next 10 years, thus young radio astronomers MUST learn to use it.

***ANSWER van der Hulst:***
Not at the moment as the goal always is to get to the science quickly

***ANSWER Warmels:***
N/A. (but I would recomment this. In my view people should not stick too much to their older software but also try new methods/technology)

***ANSWER Dutrey:***
no, never...

## B. Enhancements to the baseline ALMA

Note: the science case for the ALMA enhancements written by the ASAC can be found at: http://www.alma.nrao.edu/committees/ASAC/, click on September 2001 Enhancement Report.

**3.1. Which additional receiver bands (Bands 1, 2, 4, 5, 8 or 10) do you consider particularly important? If so, for what science goals? How would you rank the bands?**
**Band 1: 31.3-45.0 GHz; Band 2: 67.0-86.0 GHz; Band 4: 125-163 GHz; Band 5: 163-211 GHz; Band 8: 385-500 GHz; Band 10: 767-950 GHz.**

***ANSWER Walmsley :***
Band 10 seems to me the most important because it is at the highest frequency and hence is closest to the maximum in the SED of many objects which ALMA will observe in the continuum. It is als of course the frequency with potentially the greatest angular resolution. I would rank Band 4 second for "sensitivity reasons" (ie to high z CO etc). I would rank Band 8 third mainly because of the potential of the CI line.

***ANSWER Baker:***
I would rate Bands 1, 2, 4, and (especially) 8 as the most important for moderate to high-z observations of CO and [CII] lines.

***ANSWER Baudry:***
All missing bands are important for a variety of reasons BUT only bands 8 and 10 make full benefit of the unique quality of the Atacama site. We should move to the highest frequencies.
Science goals: redshifted C+, CI, Deuterated Water, Dust SED
Ranking: Band 10; Band 8; all other bands.

***ANSWER Testi:***
Listed by priority: Band 10, Band 8, Band 4, Band 5, Band 2 Cover unexplored frequency ranges. Interesting lines for ISM studies. Continuous coverage of freq range for extragalactic studies. Band 1 has lower priority wrt the other bands, the ACA and the 2G correlator, because it is already covered at the EVLA with similar sensitivities and better angular resolution.

***ANSWER Ossenkopf :***
Highest priority: band 10, next band 8, these are the two bands covering the CI lines which are extremely important to understand the structure and chemistry of photon-dominated regions.

***ANSWER Fuller:***
Priority order Band 4, 8, 10, 2, 5, 1

I'm afraid I am not convinced about the very priority of Band 1 has so far been given. I don't think the redshift low J CO lines is a particularly strong case as I'm not convinced that for a given redshift the next line up the ladder is probing significantly different gas. As I see it the case for band 1 rests primarily on the SZ/microwave background science. Yes ALMA will do it much better than the eVLA, but much of the science could be done with the eVLA. The higher frequencies are not observable anywhere else and for many of these the resolution of ALMA is essential.

I've placed band 4 above band 10 as band 10 is observationally hard and I assume expensive to implement. So is it worth investing this band with top priority before we know very much about how to work at these frequencies ?

***ANSWER Papadopoulos:*:**
Band 2, Band 8, Band 5. Tracking CO 1-0, 2-1, 3-2, 4-3 lines and the CI lines in redshift space with no "gaps".

***ANSWER Diamond:***
Band 1 for SZ, continuum dust etc. Band 4 for CO at Z~1

***ANSWER van der Tak:***
- Band 10 has highest priority: because of the spatial resolution that can be achieved, to do high-excitation molecular lines, and to study dust spectral indices. Especially for cold objects, band 10 gets close to the turnover of the Planck function.
- Band 8 has high priority because of the atomic carbon line
- Band 1 has important features (SZ imaging, high-z cold CO) but it is also covered by the e-VLA, so it should be lower priority.
- The other bands (2, 4, 5) are all interesting; priorities between these do not vary much, except that Band 2 would increase the 'leverage' of dust spectral index studies.

My ranking would be 10-8-2-4-5-1
Besides science goals, cost will determine which bands will get on first, I suppose?

***ANSWER Andreani:***
4,5,8,10. 8,10: practically unexplored. 4,5: fundamental for high-z sources and clusters

***ANSWER Tilanus:***
No real preference.

***ANSWER Cernicharo:***
Band 4 and 5 could be done in only one receiver by sacrifying the 190-211 GHz part. Lines of CS SiO (masers), HC3N, and the J=3D2-1 of many triatomic species (HNC, HCN, HCO+, NNH+), including the easy to excite line of H2O at 183.3 GHz, could be observed between 125-185 GHz. We know that ALMA will be an excellent interferometer below 400 GHz and a will support the best possible equipment at these frequencies. We need to understand all the problems at high frequencies (band 9 already funded) before going to band 8 or 10.

The science that could be done at 2 mm is for me much more important than the one for band 1 (VLA also can do some work at these frequencies) and could cover all aspects of astrophysics (cosmology, planets, star formation, galaxies, etc.). The weather will be unique at the frequencies of band 2 and ALMA will had the best imaging capacities between 80 and 380 GHz. Observations of H2O at 183 GHz of protostellar and protoplanetary disks will provide the best angular resolution observations of water in these objects.

***ANSWER Pierini:***
I think that Bands 1, 10 and 8 are particularly needed for the science cases discussed in the September 2001 Enhancement Report. I consider the extension of the potential ALMA users to astronomers interested in the large scale structure (i.e., in having Band 1) a very important boost for the establishment of the ALMA array in the widermost astronomical community.
Concerning the additional receiver bands my ranking is:
1) Band 1
2) Band 10
3) Band 8
4) Band 4
5) Band 5
6) Band 2

***ANSWER Fuente:***
High priority: Band 8 and 10 :This region of the electromagnetic spectrum is very rich high excitation molecular lines. The study of these high excitation lines is essential for the study of star formation.
Medium priority: Band 5 : the 183 GHz water line lies in this band
Band 4: includes the N2D+ 2-1 line
Band 2 : Important for the study of high-z objects

and for the study of the pre-stellar clumps (the N2D+ 1-0 line)
Low priority: Band 1 (included in the EVLA)

***ANSWER Pety:***
I am not able to make a good answer here except to say that ALMA will be made of expensive sub-mm antennas and this is not clear to me how we can easily defend to add first the low frequency bands.

***ANSWER Torrelles:***
It would be important to reach somewhen the centimeter wavelength bands (up to 20 GHz), in particular if SKA is not located in the southern hemisphere. In particular, there are many phenomena related with star formation with strong emission at cm wavelengths (e.g., HII regions, jets, masers) that they need to be studied with high sensitivity at these frequencies as a complement of the (sub)mm wavelengths studies.

***ANSWER Gueth:***
The ASAC ranking (September 2001 report) is (1) band 1 (2) band 1 (3) bands 4 and 8 (4) bands 2 and 5. I would propose to swap band 8 and band 10. Band 8 is extremely interesting because of the [CI] line which is a key tracer for many studies. As for band 10, it seems to me that observations at such a high frequency will be very complex, and therefore I'd suggest to first equip the ACA antennas, before ordering 64 such receivers! I'd also downweight band 1, which will be available at the EVLA too. The complementarity aspect is of course important, but the main driver for ALMA is high frequencies.

***ANSWER Jacq:***
I would favor highest frequencies to explore at best the site quality

***ANSWER Afonso:***
I consider of particular importance the following bands (in order of importance, in my own "biased" view...)

Band 4. Identification of [CII] line emission in the highest-z sources (z~10-14), which will allow the study of physical conditions in the youngest galaxies. Also, the identification of the highest z (z~10) galaxies (detecting these high-z galaxies will be "easy", in a deep image, but their identification/confirmation as high-z objects will be hard), through photometric redshifts. Finally, enabling CO studies at z~1 (strong galaxy evolution epoch).

Band 8. Understanding SF processes, by detecting the [C I] fine-structure transition line (in galactic sources). This line probes the separation region between atomic medium and the denser molecular region (star-formation) environments.

Band 10. Provides the highest angular resolution (planet formation studies by imaging protoplanetary disks). Detection of another [C I] fine structure transition which, in cunjunction with the one detected by Band 8, allows the determination of the [C I] excitation in star formation environments.

The above are closely placed in order of priority. Bands 1, 2 and 5 would follow. The reason for the "downgrading" of band 1 in relation to the priority already established by the ASAC is that this band overlaps with EVLA. Although ALMA will show higher efficiency, this will be, in my view, an improvement rather than a "discontinuity" in terms of observational capabilities. However, this is an important band for imaging CMB anisotropies origined by re-ionization due to early bursts of star and black hole formation.

***ANSWER Tofani:***
In order of priority: 1, 5, 10

***ANSWER Martin-Pintado:***
I would prefer to have band 5 since will give a nearly complete frequency coverage and mm (>0.8

mm) wavelengths where ALMA will allow to use its full capabilities. Scientifically there a number of molecules that can be observed with high quality that will provide complete determination of physical-chemical conditions at very high angular resolutions. Furthermore, it will allow to observe the CO emission for the redshifts range ( 0.6 to 0.9) which is not covered with the present ALMA baseline. Band 1 will be for me second priority because of the kind of science we can make (S-Z effects) that will not be done with the VLA. Bands in the submm regime (Bands 8 and 10) should be third priority until we gain experience with band 9.

***ANSWER Roelfsema:***
The ranking in the reort seems good to me, especially w.r.t. Getting the ACA early.

***ANSWER Guelin:***
- rank 1: band 10: makes full use of the site quality and antenna accuracy; provides highest angular resolution and access to important spectral lines (CI, high J lines,...)
- rank 2: band 1: some fundamental science (CMB anisotropies, SZ effect, redshifted CO and HCO+ lines,...) will make very good use of the site (size and atmosphere transparency); but not as urgent, because of the VLA
- rank 3: band 8: makes good use of the site quality; important spectral lines (CI,...);
- rank 4: band 4: very interesting science (H2CO, DCO+, CS, redshifted CO), but not urgent, because band easily accessible from lower altitude sites (Bure, NMA, Carma) and other lines of the same molecules accessible in higher bands when very high resolution is needed;
- rank 5: band 5: 183 GHz water line observations will make very good use of the site. H2S, HCN, HCO+,... lines.
- rank 6: band 2: redshifted CO and HCO+, fundamental lines of several deuterated species (DCO+, DNC,...)

***ANSWER van der Hulst:***
Band 1: redshifted co, band 9 and 10: high redshift [Cii], high excitation lines and dust.

***ANSWER Warmels:***
No comment/answer

***ANSWER Dutrey:***
(ranked)
Band 8: dust emission - fundamental for chemical aspect
Band 4: dust emission + interesting molecular transitions
Band 10: idem - but more constraining in term of weather conditions and ALMA scheduling

Band 2: interesting molecular lines
Band 5: some molecular lines
Band 1: less interesting for Star Formation, already existing at VLA

***ANSWER Gerin:***
Band 4 (and 5) are very important since
- They provide a continuous frequency coverage together with the basic configuration
- The atmosphere is transparent
- The technology is very similar to band 3 and 6 already approved
- Important molecular lines are accessible including abundant interstellar molecules (deuterated molecules - DCO+, DNC, N2D+, D2CO ), ( C3H2, H2CO, CH3OH) especially for cool or not very dense regions.

Also heavy molecules such as (CH3)2CO are likely to have many lines in the mm domain, ALMA must provide the best frequency coverage for detecting complex organic molecules.

A second priority is to cover band 8, band 10 and band 2.

Important lines such as CO(4-3), HDO, C , NH2D are in band 8.

Band 10 gives access to the highest frequency and should be tried in the future. Of most interest in band 10 are the ground state HDO line, the carbon and CO lines, the ground state CH+ line and many excited lines of heavier molecules

Band 1 has the lowest priority to my point of view. Operating ALMA at such a low frequency is wasting its performances

## 3.2. Any comments on the importance and science case for the Atacama Compact Array (ACA) or the second generation (2G) correlator?

***ANSWER Walmsley*:**
I have always been doubtful about ACA though it is quite clear that for some projects involving large (for ALMA) scale mapping, it will play a key role. The 2G correlator seems to me extremely important both because of gains in sensitivity and because of the potential for spectroscopy with high spectral resolution an many channels. I personally put this higher than ACA.

***ANSWER Baker:***
The ACA should take precedence over all other enhancements,since it will broaden the range of possible science projects more significantly than any other option.

***ANSWER Baudry:***
The ACA truly improves the imaging capabilities and fidelity A bit of caution: one should not 'sell' the ACA in saying that ALMA would be incomplete without the compact array ... even though many people think that the field of view is too small.

The Second Generation Correlator (2GC) as proposed by Europe (the 'Unified concept' with Japan has not yet emerged) offers really new possibilities: higher sensitivity (9% better than the NRAO design because of 3-bit instead of 2-bit correlation), 10 times more channels, great flexibility (assigning subbands or groups of subbands anywhere within the 2 GHz ALMA basebands); the latter would allow us for example to prepare multi-line and multi-continuum observations. (The European plan is a smart way of using flexibility and spectral resources!)

***ANSWER Testi:***
Both are extremely important. Expecially the 2G correlator: the VLA experience has shown us that the correlator may be the bottle neck of an entire instrument! The European proposal for 2G correlator will offer higher efficiency and an enormous increment in the spectral capability over the baseline correlator.

***ANSWER Ossenkopf:***
It is obvious that the ACA is the most important upgrade at all. I consider a good zero-spacing more important than a very dense sampling of the u-v plane.

**ANSWER Fuller:**
I would rank ACA somewhat above the 2G correlator, but they are both very important.

***ANSWER Papadopoulos::***
I consider both of them are very important

***ANSWER Diamond:***
I don't understand the real drivers behind the ACA (are they political?). I would prefer to see a 2G correlator with enhanced line and continuum capabilities.

***ANSWER van der Tak:***
The ACA is rightfully a top priority of ALMA. For example, the primary beam at 650 GHz is 10''. Most sources have emission on this scale which will be resolved out.

The 2G correlator would be good to have, but shouldn't be a high priority.

***ANSWER Tilanus:***
I am in favor of the ACA over the 2G correlator:

- ACA will be much less easy to do as a retro-fit than the 2G correlator. Overall development of ALMA will benefit a lot from an early commitment to ACA through a concurrent development of the necessary infra-structure.
- ACA addresses a fundamental short-coming of ALMA, one that may well prove to be rather debilitating for many projects and impair the corner-stone mosaicking mode.
- The merits of the 2G correlator are less fundamental and more science driven. While no less exciting, given a choice I prefer to address the more fundamental issue first.
- Waiting a while longer with the 2G correlator will only mean increased capabilities and less risk.

***ANSWER Cernicharo:***
Both are important but 2G correlator will increase the observing capacities of ALMA considerably. For me, the uropean 2G correlator proposal, although perhaps needing some improvement, is more realistic than the japanesse one. The CA will also be an important enhancement of ALM

***ANSWER Giard:***
Both the ACA and 2GC are in my view of higher importance than aditionnal bands.

2GC: because the number of spectral channels of the 1st correlators ill be very poor in the wide band modes, and this will limit he ALMA science.

ACA : because past experience in all astronomy domains has shown hat missing the large angular scales allways means missing ost of the mass in the objects.

***ANSWER Pierini:***
I think that the ACA is fundamental for several scientific topics and that, maybe, the science goals set for most of the same topics or for most of the others would not suffer because of the absence f the 2G correlator.

***ANSWER Fuente:***
I consider that the ACA would be the most important enhancement of ALMA. Because of the extraordinary high angular resolution of ALMA, missed flux will be a major problem. The ACA is essential to recover this flux and be able to build realistic images.

***ANSWER Pety***:
I work a lot on the improvements that ACA can bring to the wide field imaging capabilities of ALMA. So I will not elaborate anymore on that subject.

For the second generation correlator, my understanding is that it will add a lot of flexibility which is needed for line surveys. As line surveys is an area where ALMA will bring ignificant improvements, we should go for it.

***ANSWER Gueth:***
Having participated to the ACA evaluation test in 2001 I'm convinced that the ACA will provide a significant improvement in the image quality provided by the ALMA instrument. As for the 2G correlator, I'm missing a detailed description and comparison of the performances of the 1G and 2G correlators

***ANSWER Jacq:***
ACA is of high interest to amplify ALMA imaging capabilities 2GC would significantly improve sensitivity, channel numbers, flexibility.

***ANSWER Afonso:***
Both are highly important to improve ALMA capabilities. However, it seems to me that the need for ACA is more pressing, since: (a) it will recove image structure lost by the missing short spaces in ALMA, (b) improve its flux accuracies, minimising errors and (c) it can be used as a stand-alone instrument, thus maximizing the science output from the ALMA+ACA venture.

***ANSWER Tofani:***
They are both top improvements, in particular the second one

***ANSWER Martin-Pintado:***
For me ACA will be of great importance, since for many projects ALMA a large fraction of the flux will be lost, making very difficult the interpretation.

***ANSWER Roelfsema:***
see above

***ANSWER Guelin:***
ACA will considerably enhance the image quality and reliability for extended sources and is therefore very important.
It seems difficult to decide upon the urgency of the second generation correlator, as long the devlopment of the first correlator (e.g. samplers) is not completed and the total number of antennas (ACA or no ACA, other 12-m antennas) is not known.

***ANSWER van der Hulst:***
No, importance appears obvious to me: speed and spectral resolution for 2g and extended and low surface brightness objects (there will be many!) for ACA.

***ANSWER Warmels:***
I believe that the need for the ACA will be become evident after we have obtained experience and exciting science. Short baseline information has become important for all interferometers after some time. ALMA will not be an exception.

***ANSWER Dutrey:***
ACA is very important for mosaicing

## C. Preparation for ALMA science and ALMA meetings

**4.1. The EU Framework 6 program offers the opportunity to organize scientific workshops and other networking activities for preparation and coordination of the European ALMA community through the OPTICON and RADIONET networks, sponsored by the EU. This includes links with the optical/IR and radio communities. Do you have suggestions for topics for ALMA-related workshops in the 2003-2007 period?**

***ANSWER Walmsley*:**
Perhaps a workshop on "Stellar Astronomy with ALMA" would be useful. A second possibility would be "Solar System Science with ALMA".

***ANSWER Baker:***
One or more rehashes of the "Science with ALMA" workshop would be obvious possibilities. I think a workshop on imaging techniques in radioastronomy would also be plausible (this could be coupled with bolometer array mapping techniques, which will also be of interest to ESO vis-a-vis APEX). Multiwavelength cosmology and multiwavelength star formation workshops would be useful but perhaps less appropriate for this funding stream.

***ANSWER Fuller:***
I think we should be trying harder to discuss the impact of ALMA on non-traditional submm users, so what about a workshop on ALMA and the intermediate redshift universe and AGNs. But it is also important we keep the attention of the submm community so organize workshops related to star formation and chemistry.

***ANSWER van der Tak:***
not right now

***ANSWER Andreani:***
Synergy with other complementary (present and future) instruments

***ANSWER Tilanus:***
no suggestions

***ANSWER Cernicharo:***
Too early ?

***ANSWER Freudling:***
High-redshift Universe

***ANSWER Pierini:***
I would like to propose the following topics.
1. Dust grain size distribution in different Galactic/extragalactic environments: initial condition and evolution.
2. Chemical richness of the interstellar medium.
3. Cosmological history of star formation.
4. Starbursts and dust enshrouded AGNs

***ANSWER Fuente:***
I suggest the organization of workshops centered on a scientific topic (star formation, planets formation, evolved stars, extragalactic, high-z objects...). These workshops would induce different groups to collaborate and prepare themselves for ALMA.

***ANSWER Pety:***
No particular ideas.

***ANSWER Torrelles:***
A workshop about general interferometry, from optical, IR, and radio wavelengths

***ANSWER Gueth:***
I think that it is of prime importance to make sure that the european astronomical community gets prepared for ALMA. This implies regular meetings with at least two goals:

- circulate the latest news (project status) and get inputs from the community --> short meetings following the model of the Nov. 8 workshop
- prepare the whole astronomical community (not just the mm expert groups) to ALMA --> science meetings, similar e.g. to the Washington meeting in 1999

***ANSWER Jacq:***
none

***ANSWER Afonso:***
Nothing other than the obvious discussions/presentations/meetings where the scientific prospect of ALMA is discussed (in light of the new sub-mm/mm/radio discoveries) and technical status of the project is brought to the community. Maybe also something on software advances needed for ALMA (I have no doubts that new/improved algorithms will be needed, for example).

***ANSWER Tofani:***
A careful coordination with the european community at large

***ANSWER Martin-Pintado:***
I think that building ALMA is really a technical challenge that require all the expertise in Europe. It would be good to have some workshops which should be more technically oriented with PhD students and Post-docs to encourage them to get involved in ALMA.

***ANSWER Guelin:***
Workshops on selected scientific topics that will particularly be boosted by ALMA (protoplanetary disks, high redshift quasars,...), rather than general all-topic meetings. Schools on mm-wave techniques and interferometric imaging.

***ANSWER van der Hulst:***
I think we need two kind of workshops: scientific and practical i.e. directed toward the data reduction problems and issues. Broad science topics could be: astrochemistry, star formation, the high z universe, dust & molecules in the universe (but these are of course very obvious choices)

***ANSWER Warmels:***
We should try to find ways to getting the (unexperienced) community involved in the development of the Operational model for ALMA and the user software development (OT, Reduction Software, Pipelines). Hence a couple of workshops in these areas would be useful. They could be of the same type as the 8 Nov meeting.possibly more specific in some areas.

Summer schools, but the 2003-2007 period may be too early for this.

***ANSWER Dutrey:***

- Instrumental school (one week) on differences and similarities between mm and optical interferometric technics
- Several schools/workshops oriented on ``high angular resolution astronomy'' (resol < 0.2-0.5'')
- For various astronomical topics thinking in term of observational parameters, radiative transfert, (M)HD simulations, etc... My experience at Bure tells me that when the geometry is known mainy new things can be done and the way by which the physical parameters can be estimated is different.
  These schools concern all wavelengths (optical to mm range).
- A workshop on Mosaicing: imaging technics, observational limitations, new constrains on physical

- parameters (dynamic needed etc....)
- A workshop on Polarization at mm/submm waves ...

***ANSWER Gerin:***
- Role of magnetic field for star formation/
- Circumstellar disks
- Connection between Starburst galaxies and AGN
- Line and continuum Radiative transfer at mm wavelength (summer school )

**4.2. The aim of the Nov. 8 meeting was to update the European community on the status of the ALMA project and sollicit input on specific issues, in this case science operations. Was this aim achieved? If so, how often should such general ALMA community meetings be organized (once per year, every two years, ...)? Suggestions for improvements?**

***ANSWER Walmsley:***
I think the aim was achieved. Once every year is too frequent.

I think that the Nov.8 meeting did not sufficiently cover the range of science that one will do with ALMA (eg Solar System and Stars as mentioned above). Also the whole field of "normal galaxies", magellanic clouds etc etc. One of the aims of such meetings is to convince the ESO community that ALMA is important for them and I am not sure that was done.

***ANSWER Baker:***
From my point of view, this meeting was a success; between the talks and the recommended reading before the meeting, I got a great deal of useful information. I only hope it was equally useful for the organizers... I think an annual meeting (either at ESO or at the RSC, once identified) would be extremely useful. Once operations begin, I think a useful model would be the annual "Keck science meeting" which is organized internally by the CARA institutions. Speakers give 15 minute talks or posters on recent science highlights (no long review talks!), and at the end of the day the director of the observatory gives a somewhat longer "state of the observatory" presentation which is followed by discussion. My impression is that this meeting serves several purposes: it gives users a variety of examples for how to exploit the available instrumentation (both scientifically and technically), and it gives the observatory staff a chance to get feedback all at once from a wide swath of the user base. In one-at-a-time interactions, it can be harder to tell which suggestions from users are the most important ones to follow up on.

***ANSWER Baudry:***
Yes the initial goal was achieved. Such a meeting every two years would probably not be enough to maintain a high level of motivation/interest within Europe. Once per year and make it short (one day) seems a good formula to me.

***ANSWER Testi:***
I think that it was a very succesful meeting and I would suggest to have a similar meeting either every year or every two years.

***ANSWER: Ossenkopf:***
We need more synergy between HIFI and ALMA. Apart from smaller topics like the calibration issues we should have more scientific workshops on what each of the instruments can do for the other. To me it is, however, not clear whether this fits in FP6 because HIFI is an ESA project.

***ANSWER Fuller:***
Yearly and additionally before major project decisions or events.

***ANSWER Papadopoulos:***
once per year. It will be a good idea in every meeting to have informed people on the "hard" boundary conditions, e.g. this and this aspect of ALMA is now *fixed*, these are open and need discussion etc.

***ANSWER Diamond:***
It was an excellent meeting and for the first time I felt that I was being consulted on ALMA issues. Up to now much of the cm-wave community has been 'excluded' through problems in communicating. Due to the length of the project I would suggest holding such meetings annually.

***ANSWER van der Tak:***
once a year.

***ANSWER Andreani:***
Once per year.

- Meetings too badly advertised
- Too small the community: always the same (old) people
- Invite young people.

***ANSWER Tilanus:***
unfortunately I missed the meeting.

***ANSWER Cernicharo:***
Yes, but from my point of view the impression most people had is that ALMA is a well defined, well under control, and correctly scheduled project. The real problems behind a so complex project were missing in this meeting.

***ANSWER Giard:***
Yes, once a year

***ANSWER Freudling:***
every two years

***ANSWER Pierini:***
I think that the aim of raising interest and discussion was achieved. General ALMA community meetings should take place once per year, so that topics may be fully investigated well in advance to the decision taking, and they should last a couple of days.

***ANSWER Fuente:***
Perhpas it is a good idea to organize this meeting once a year to keep the scientific community informed about the project status, and discuss some hot topics. In addition to this meeting, it would be convenient to organize workshops on more specific topics (see 4.1).

***ANSWER Pety:***
It is always good to have some formal presentation of the project and of its scientific goals. There have been sensible discussion around central current problems of the ALMA project. So the aim has been achieved.

Travelling to one place in Europe may be expansive for laboratories. So it would be good to have longer session (two or three days) every two years. Moreover, saturday could be one of those days to allow people to spend the week-end night there and have low air-fare.

***ANSWER Torrelles:***
I think the aim was achieved. Thank you and congratulations for that excellent work. We all will benefit if this kind of meetings is once per year.

***ANSWER Gueth:***
I have the feeling that most of the participants were looking for fresh news from the ALMA project - which is normal since this was the first meeting of that kind. It seems to me very important that similar meetings be organized regularly (e.g. once per year).

***ANSWER Jacq:***
I considered the Nov. 8 meeting as quite interesting. That could probably be good to have a one year period for such a meeting.

***ANSWER Afonso:***
Yes, I believe so. It is still early (in the ALMA schedule) and some issues are still very uncertain, but this is the time to get those issues discussed and settled. I think that these meetings are fundamental for this and should happen once every year - this seems to me a suitable time-scale for significant developments in the project to take place.

***ANSWER Tofani:***
If we are considering general ALMA meetings probably this one day organization once a year is OK. We will probably need more meeting on specific topics

***ANSWER Martin-Pintado:***
For me the aim was achieved since I got aware of the kind of ideas that are being discussed for the ALMA operations. I think that one day meeting is too short. In the future, we should try to get two or three days meeting once per year with scientific contributions on selected topics and also discussion on the required capabilities of ALMA and the data reduction packages.

***ANSWER Guelin:***
It is important to update regularly astronomers with current project status (e.g. every 6 months by a `Letter', every 2 year by meeting). Solliciting inputs e.g. on the RSC is fine, but one should be aware that the meeting attendance may not reflect the whole community.

***ANSWER van der Hulst:***
I think this was a very useful meeting, also for the purpose of building a "live" alma community. we all know each other bo do not yet perform as a community. i think a meeting at least once a year is required. also in the buildup phase, just to keep the community involved in the process and get them prepared.

***ANSWER Warmels:***
I found th meeting extremely useful and would propose to have such a meeting every year. Eventually the organisation should be done by the RSC. Depending on progress one or more topics could be discussed in more depth. See also my remarks above.

***ANSWER Dutrey:***
Goals were achieved, I suggest one meeting per year. It should be fine to emphasize different scientific topics each year in order to cover most of them in two years.

***ANSWER Gerin:***
Every two years or once a year but on a 3 day basis tof oster discussions. One day is too short.

## D. Others

### Feel free to comment on any other ALMA-related issues.

***ANSWER Baker:***
(1) Santiago vs. RSC staffing issues

Independent of how the RSCs are ultimately organized, I think it is extremely important that ALMA not fall into the trap of overstaffing the RSCs at the expense of the operations center in Santiago. Having a critical mass (in particular, of *scientists*) in close contact with the telescope will be just as important for ALMA as it is for the VLA and the PdBI. If this is not prioritized in the early phase of the project, it will be too late to fix by the time the array comes on line at the end.
It is my impression that the SMA has suffered from this problem-- too many scientists in Cambridge, too few scientists in Hilo-- with the result that it is more difficult to attract potential hires to Hilo, and thus more difficult to finish commissioning (without exorbitant back-and-forth travel costs). Every new hire in Camridge makes the imbalance worse. Note that strengthening the scientific base in Santiago also makes sense for ESO from the point of view of recruitment for positions at La Silla and Paranal. I can think of a couple of strategies which would help avoid the problem of overstaffing at the RSC(s):

(a) Make all support astronomer positions 2 years in Chile + 1-2 years atthe (European) RSC. This is similar to the arrangement for some of the joint Chile/U.S. postdocs, and gives scientifically motivated staff the chance to consolidate their scientific record in Europe (where, presumably, they will have a less intensive support burden) before the next time they have to go on the job market. From the point of view of ALMA, it means that everyone providing support to users will have had two years of recent, hands-on experience with the array-- a big plus. This sort of policy needs to be adopted from the beginning if it is adopted at all, and in particular, before the agreement with the RSC is signed; it will not necessarily be in the self-interest of whatever national agency funds the RSC to allow 50% of its scientific hires to be working outside the host country.

(b) Offer a limited amount of guaranteed time as a "signing bonus" to help recruit support astronomers to commit to spending two years in Chile. The precise combination of time and frequency (more time at lower frequency vs. less time at higher frequency) could be left up to the individual, within certain constraints. This time could come out of "DDT" if "GTO" is deemed too offensive a concept. Basically, if ALMA expects that relatively young scientists should break their backs to get the array working, there should be some effort made to see that they do not destroy their own careers (as active scientists) in the process. In the early stages of commissioning, of course, self-interest will also be a powerful motivation to get things working.

(2) Time allocation

I would be in favor of a single TAC, since this would encourage intercontinental collaborations. I would suggest that the overall distribution of time among different scientific areas be determined on a per-semester basis by some sort of super-TAC, rather than allocated in proportion to the number of proposals each panel receives (I think the projects ALMA could do and the projects ALMA should do are not necessarily the same thing, and that some areas of astronomy are simply more active and interesting than others). Balance between European and North American proposals, to the extent that it needs to be enforced, can be guaranteed by relative prioritization in execution of the "B" rated proposals (on an A-B-C grading scale), according to the nationality of the PI.

***ANSWER van der Tak:***
no comments right now

***ANSWER Cernicharo:***
I think that a technical advisory committee could be a big help for the ALMA office and for the project.

***ANSWER Torrelles:***
In order to define a possible RSC I think it is very important that the ALMA team has persons that have been involved before in the using and commissioning of major radio interferometer

***ANSWER Jacq:***
If it does not exist: some kind of electronic letter to inform subscribers of the ALMA project progress and events. (initial list from the 8 nov. Meeting ?)

***ANSWER Afonso:***
**I** would personally like to know more about the present status of the EU Framework 6 initiatives related to ALMA. Some discussion existed last November, but quite brief. Anyway, I understand this is almost a "private" institutional endeavor, and such information must be sought directly with the institutions.

***ANSWER Martin-Pintado:***
I have got really involved in ALMA since a few months ago and my impression is that we need more astronomers who wants to contribute to technical aspects through the science IPTs.

***ANSWER Guelin:***
ESO will ask for EU money under the FP6 New Infrastructures line for the ALMA "imaging", "calibration" and "archiving" softwares. How will the activities funded by FP6 be coordinated with those already funded by the ALMA project and presently listed in the Computing Subsystem workpackages (Task 7 of the project). Will this money be simply used to increase the number of FTEs attached to the Task 7 workpackages already defined by the SSR (telescope calibration, pipeline, off-line data reduction,...), or will it be used to open new workpackages. Who will define these enhanced or new workpackages and who will coordinate the work? Will it be the European Computer IPT Manager or the Science (Task 9) IPT Manager? So far, to my knowledge, the definition of the workpackages belonging to the Science Subsystem has not been properly announced to the community.