6-7-99

ALMA Phase 1 Management Plan

Version 1.0

1. Introduction

The ALMA Phase 1 Management Plan describes the composition of the project team and work program for activities to be carried out in under the European Memorandum of Understanding (MoU) concerning xthe design and development phase (Phase 1) of a large mm/sub-mm array.

The objective of Phase 1 is to completely define a joint program to construct and operate the ALMA (Phase 2). This definition will be the basis for a European proposal for Phase 2 to be submitted not later than June 2000. The products of the design and development phase include:

- scientific rationale reflected in unambiguous top-level scientific requirements,
- technical approach and preliminary design validated by demonstrated performance on prototype components or subsystems, and on single-antenna prototype systems provided by the U.S. and Europe,
- management approach and a precise division of responsibilities for deliverables embodied in executed agreements between the participants, and
- schedule and cost-to-completion derived from a detailed project work breakdown structure (WBS) with commitment by the participants to deliver the elements for which they are responsible for the estimated cost.

A parallel design and development phase of a large mm/sub-mm array (the MMA) is being carried out in the U.S. by the National Radio Astronomy Observatory (NRAO) under a cooperative agreement with the U.S. National Science Foundation (NSF). Under the U.S./European Memorandum of Understanding concerning the design and development phase of a large aperture mm/sub-mm array to be known as the Atacama Large Millimeter Array (ALMA), expected to come into force in June 1999, the work program described here will be integrated into a joint work program with the U.S.

2. Project Organization

The top-level organization of the European project team is shown in Figure 1. The program office is made up of:

European Project Manager (EPM)	Richard Kurz from ESO
European Project Scientist (EPS)	Stephane Guilloteau from IRAM
European Deputy Project Manager	Richard Wade from Rutherford Appleton Laboratory (RAL)

The EPM has overall responsibility for the Phase 1 ALMA design and development work in Europe. His primary responsibility is to ensure that the Phase 1 activities are performed in a timely and cost-effective manner. The EPM reports to the European Co-ordination Committee (ECC) and is the principal point of communication with the ECC. The Deputy Project Manager assists the EPM in carrying out his functions, particularly in the planning and definition of the Phase 2 program.

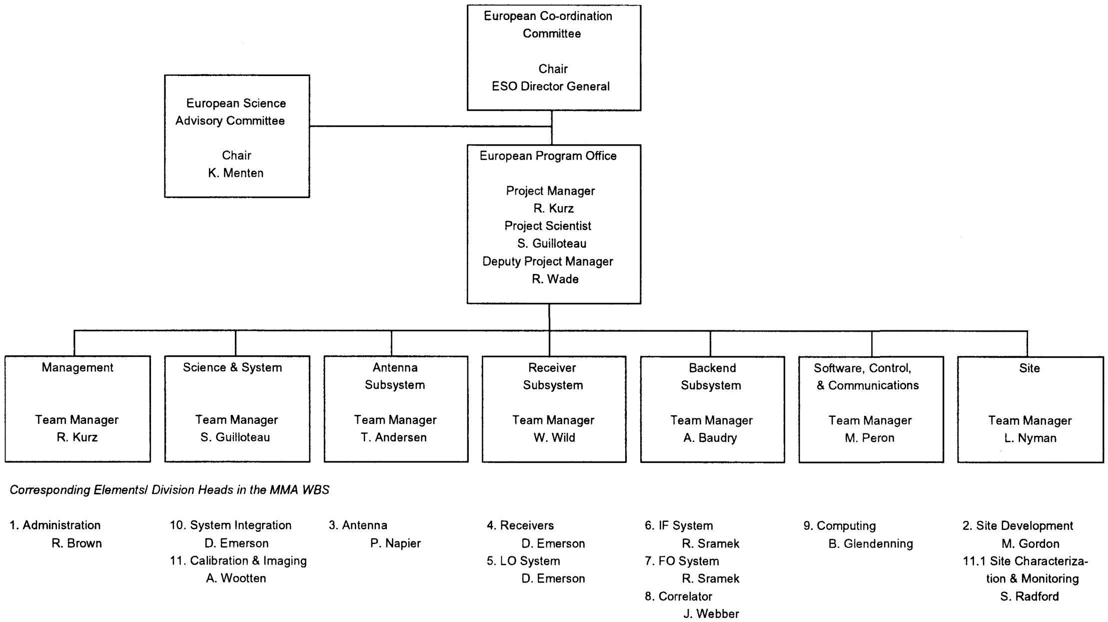

Figure 1. European ALMA Phase 1 Project Organization

The EPS is responsible for ensuring that the Phase 1 activities are performed in accordance with the scientific goals of the project. He provides leadership in establishing the scientific and technical requirements and specifications and is responsible for ensuring that the technical design meets these requirements. He is also responsible for maintaining interactions with the European scientific community and with counterparts in the U.S. and other participating countries.

ESO will provide administrative and secretarial support to the program office.

The Phase 1 work will be performed by seven teams, as shown in the figure. The seven working teams are led and managed by the following:

Management	European Project Manager
Science & System	European Project Scientist
Antenna	Torben Andersen from Lund Observatory
Receiver Subsystem	Wolfgang Wild from NOVA/SRON Groningen
Backend Subsystem	Alain Baudry from Observatoire de Bordeaux
Software & Control	Michele Peron from ESO
Site	Lars Nyman from OSO/SEST

The elements of the NRAO work breakdown structure (WBS) for MMA corresponding to the various elements of the European organization and the NRAO Division Heads for these elements are shown below the European organization.

The Team Managers will be responsible for planning, coordinating, and monitoring the work in their areas. For planning, this involves pulling together a complete organization/WBS with personnel assigned, statement of work/task descriptions, schedules, and resource requirements for all work in their area. Resource requirements include people (FTEs), equipment, travel and other direct costs with a designation of whether these are in-kind contributions or will have to be paid for from the in-cash contributions to the program. The Team Managers will also be responsible for keeping track of and reporting what's happening in their area.

There will be a teleconference of the Team Managers every week or two at a minimum. The Team Managers will submit written monthly progress reports to the EPM, including technical progress, schedule status, and resources expended. In turn, the EPM will provide a written quarterly report to the ECC.

2,1 Science & System. The Science & System team covers aspects of the ALMA project ranging from high-level science requirements to technical specifications relevant for the other groups. Its role is essential in all interface aspects between the other ALMA teams. The organization of the Science & System team is shown in Figure 2. The members of the overall team identified so far are listed. In addition, the principal points of contact for interaction with the other teams are designated. The Science Advisory Committee (SAC) will interact closely with the team and several members of the SAC will be directly involved in the Science & System team.

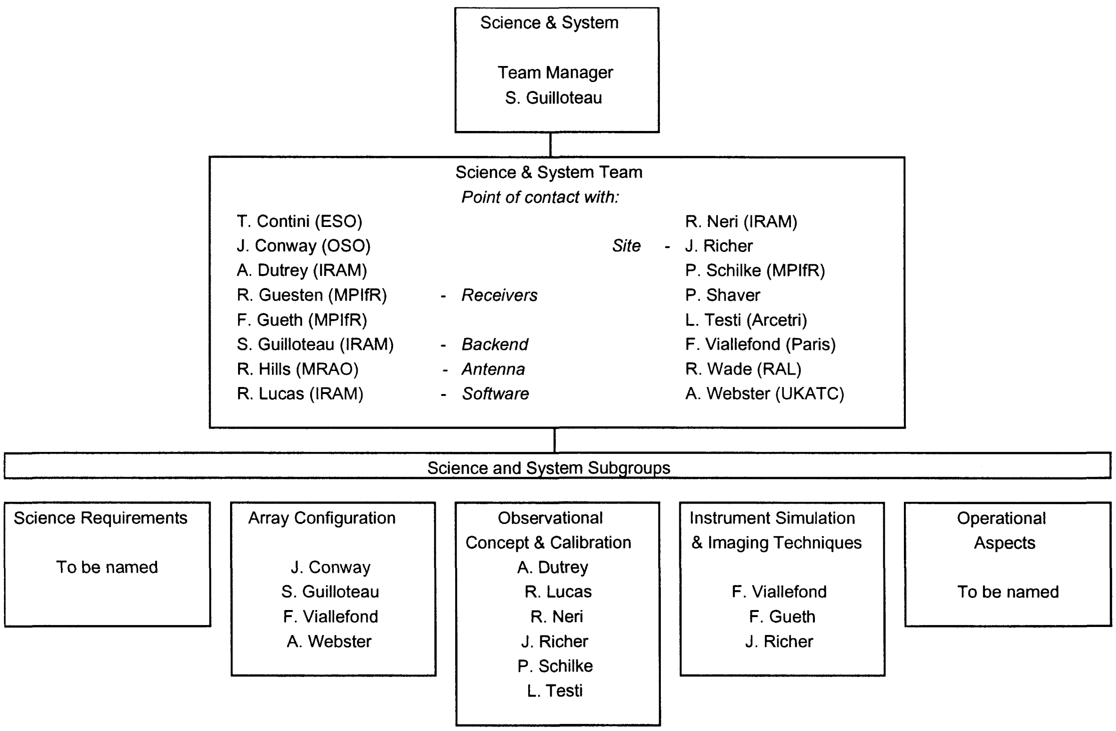

Figure 2. Science & System Team Organization

Five subgroups, responsible for specific issues, have been identified along with the provisional membership of three of the subgroups shown in the figure.

Science Requirements
Array Configuration
Observational Concept & Calibration
Instrument Simulation & Imaging Techniques
Operational Aspects

Membership of the remaining two subgroups, as well as the subgroup leaders have not yet been identified.

2.2 Antenna Subsystem. The antenna team will lead the development of an antenna prototype through an industrial contractor and be responsible for test and evaluation of the prototype antenna. As shown in Figure 3, the antenna team will be centered at Lund Observatory. The team at Lund will consist of the Team Manager, two project engineers, and a graduate student. This work is done with support from specialists at IRAM and ESO. Support will be coordinated by the persons shown. In addition, there will be frequent contacts with U.S. colleagues on the project to coordinate development activities. The contract for the design and building of the prototype antenna will be technically monitored by the antenna team and administered by the Contracts & Procurement organization at ESO.

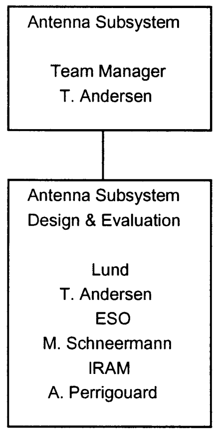

Figure 3. Antenna Team Organization

2.3 Receiver Subsystem. The receiver area will have participation from a large number of institutions in Europe, as shown in Figure 4. The overall technical direction of the effort will be focused in the joint receiver subsystem design group, consisting of members from Europe and the U.S. It will be responsible for formulating a joint U.S./European receiver concept and overall receiver design, the definition of modules and interfaces between modules and the main system, LO and IF interfaces, standard connectors, etc. The European members shown are the lead persons from principal institutions participating in the receiver work. The European receiver team manager, together with his U.S. counterpart, will coordinate the work of this group.

The dewar group will work on the overall dewar design including the optics design, optics prototype construction, definition, design and analysis of the cryostat, the construction of a protoype cryostat, and a plan for mass production of horns. The SIS mixers and amplifiers group will work on mixer modules and IF amplifiers. NOVA/SRON will develop a 650 GHz mixer and a plan for mass production of mixers, OSO will develop a 350 GHz mixer and planning for industrial production, MRAO will work on high frequency sideband separating mixers in finline technology, IRAM will adapt and test a mixer design with a moving backshort, and DEMIRM will develop a 440 GHz mixer. ETH Zurich will develop and fabricate devices for IF amplifiers. CAY has proposed involvement (under the provision that Spain joins ALMA) in the area of IF amplifiers in collaboration with ETH. The SIS junctions group will work on the evaluation of the needs for SIS junction mass production, of the required development effort, and a plan for the fabrication of SIS junctions for the

1200 mixers of ALMA. The local oscillator group will work both on conventional (multiplier chain) and photonic LOs. RAL will lead work on a prototype LO system based on conventional, multiplier technology, and MPIfR/KOSMA will lead work on the development of a photonic LO system. The control and test electronics group will work on the electronics to control, tune, monitor, and automatically test the receiver system. MRAO and OSO will develop techniques for automatically measuring the noise and optical performance of SIS mixers.

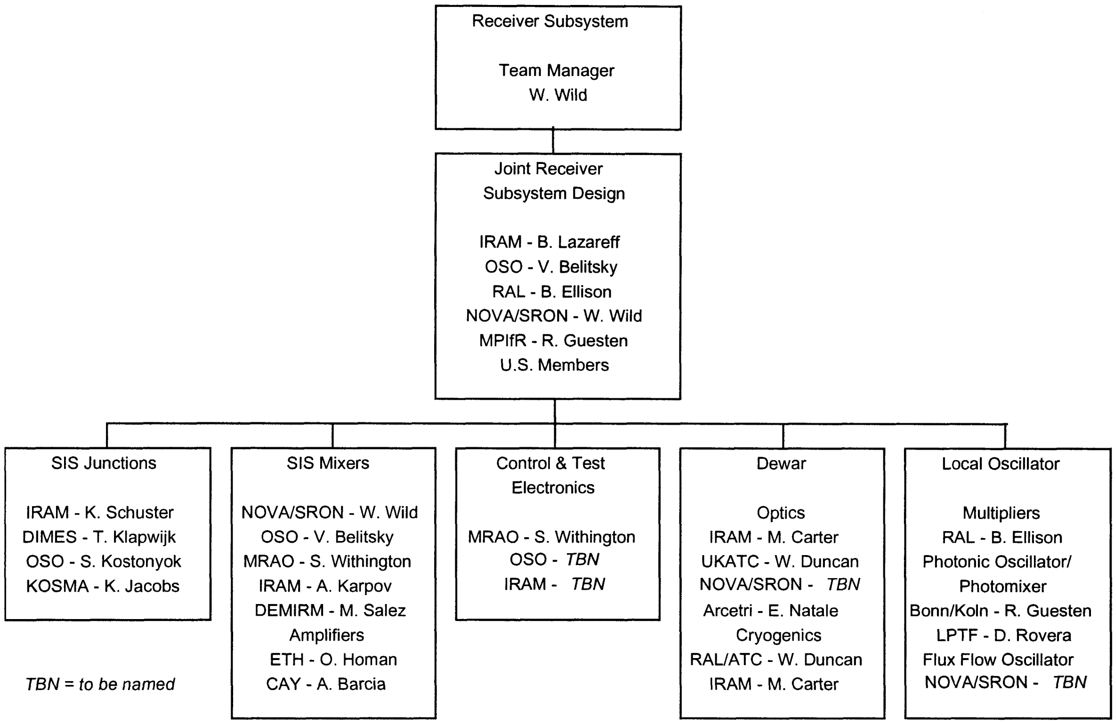

Figure 4. Receiver Team Organization

2.4 Backend Subsystem. The backend subsystem will also have participation from a large number of institutions in Europe, as shown in Figure 5. The joint backend subsystem design group, consisting of members from Europe and the U.S. will lead the technical effort. It will be responsible for formulating a joint U.S./European overall backend architecture and design, including IF electronics, fiber optic signal transmission and distribution, and an advanced correlator. The European members shown are the lead persons from principal institutions participating in the backend work. The European backend team manager, together with his U.S. counterpart, will coordinate the work of this group.

Development activities relating to fast ADCs and FIR digital filters will be carried out by the AGSO consortium, together with MPIfR and RAL. Technologies for connecting components within the correlator system promise to be a major area of study. This effort will be led by IRAM. Closely related to the question of interconnect technology, but of more general scope (cooling, maintenance of signal coherence, minimizing signal cross talk, etc.) is the design and fabrication of the correlator boards. This study will be undertaken by NRAL, NFRA, and Arcetri. Study of the IF and filtering, signal conditioning and fringe stopping portions of the signal chain will be led by AGSO. Study and development of the signal distribution strategies, including especially the use of fiber optic technologies, will be led by NRAL. Time and LO distribution and synchronization as well as control signals and auxiliary data paths will be examined in the system wide context. Advanced IC technologies and design tools will be crucial to the realization of the advanced correlator. A separate overview of developments that may prove useful to this project will be prepared by Arcetri, RAL, and NFRA.

System verification and test, including repair and maintenance strategies, will be studied in detail at a later stage in Phase 1. Similarly, matters of data flow and on-line analysis requirements will be postponed. Initially, the joint backend design group will consider the requirements placed on the general architecture by these aspects.

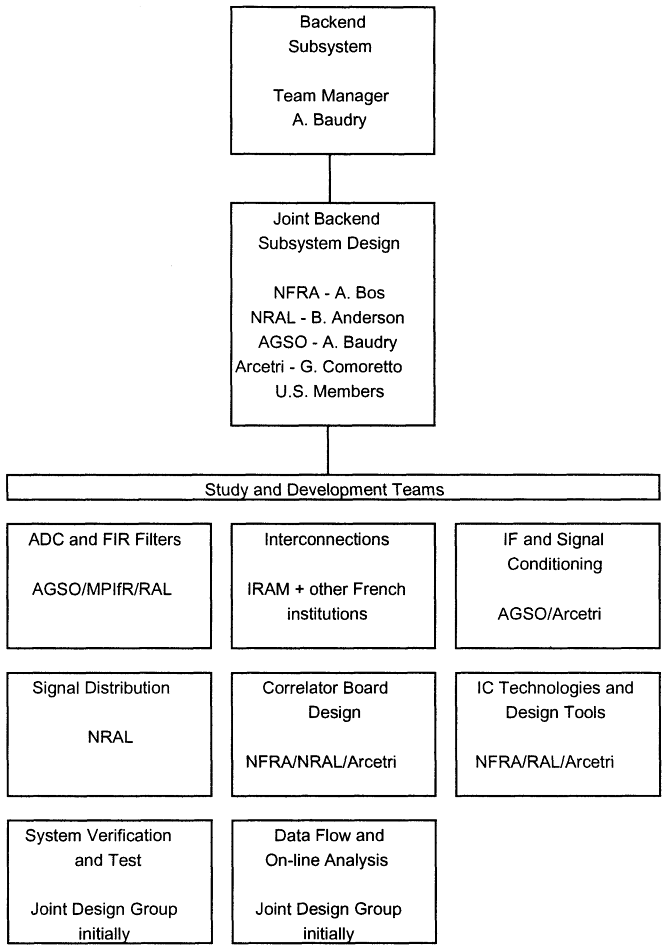

Figure 5. Backend Team Organization

2.5 Software, Control, and Communications. The top-level software, control, and communications architecture definition and subsystem design will be a joint activity with participation by the European institutions shown in Figure 6. The science software requirements group will have a critical role in defining the concept of ALMA science operations and the corresponding requirements on software, controls, and communications. ESO will lead the effort on software engineering to define the standards and processes to implement the software subsystems. A limited core of common software will be defined and implemented in Phase 1. Once the overall system is specified and designed, subgroups with responsibility for development of the various subsystems will be designated from the participating institutions.

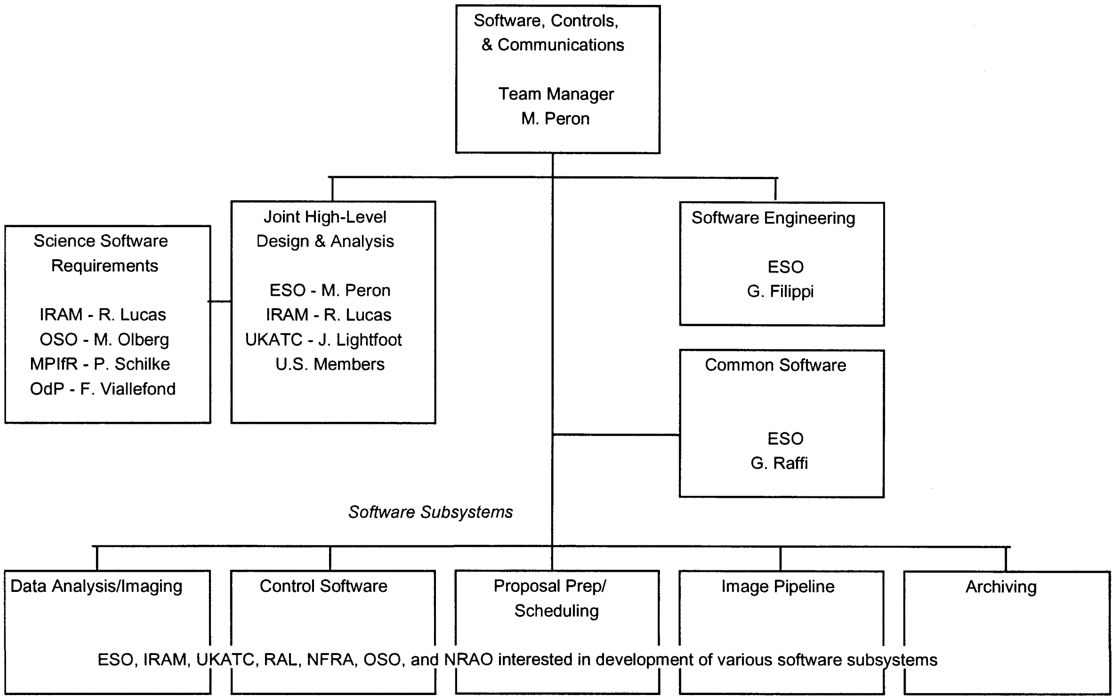

Figure 6. Software, Control, and Communications Team Organization

2.6 Site. Most of the work on site development and characterization will be the responsibility of ESO or OSO personnel in Chile, as shown in Figure 7. ESO will be responsible for site development planning, as well as all aspects of relations with Chilean institutions and governmental agencies. Angel Otarola from ESO will be responsible for operation of both the European and NRAO site characterization equipment at Chajnantor. Data analysis in Chile will be under Guillermo Delgado from OSO with MRAO Cambridge taking the lead in analysis and interpretation of the radiometric phase calibration data.

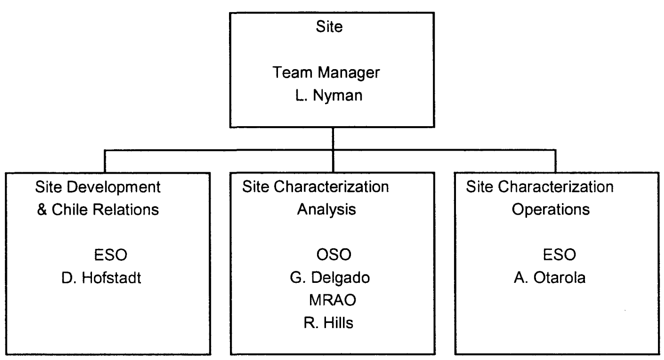

Figure 7. Site Team Organization

3. Phase 1 Work Program

Along with the technical design and development work outlined in the following subsections, each team will be responsible for defining, planning, and costing the

Phase 2 work in their area. The management team will guide this process and will compile the inputs into the overall Phase 2 plan and proposal.

3.1 Science & System. Although the Europeans and the U.S. are in agreement on most of the top-level scientific requirements for ALMA, further definition is required for the areas listed below. Activity will focus on jointly defining the specifics of these items.

Instrument Definition
Instrument simulation
Array configuration
Longest baseline
Pointing accuracy requirements
Wide-field imaging requirements
Total power requirements
Frequency coverage

High-level Science Issues
Scientific priorities
Preparation of ALMA community
Public relations and outreach
Time allocation policy

Operation Concept & User Interface
Observing strategies
Calibration strategies
Proposal handling
Analysis software specification

System Aspects
Frequency layout
Receiver specification
Control system specification
Archiving specification
Correlator specification

3.2 Antenna Subsystem. Effort in the antenna area is focused on the design, construction, assembly, and testing of prototype antennas by both the U.S. and Europe. Each side will procure a prototype antenna satisfying the common technical requirements. These procurements will be closely co-ordinated. We will jointly evaluate and test these antennas as well as jointly design the apex (subreflector) module and transporter for the prototype antennas. The antenna team will investigate metrology techniques for possible evaluation on the prototype antennas.

3.3 Receiver Subsystem. We plan to produce a single joint design of the receivers at the subsystem level. As indicated in the description of the receiver team, a wide range of component development activities are proposed. A near-term aim of the planning in this area will be to reduce duplication and overlap in the developments. We do not plan to build a full receiver prototype in Europe during Phase 1. NRAO is designing and will produce the receivers to be used in evaluating both prototype antennas. These are not prototype receivers for the full array. Conventional and photonic local oscillators will be investigated on both sides. Both sides will do production planning and cost estimation for the full array receivers and NRAO plans to begin the production of a prototype receiver in Phase 1.

3.4 Backend Subsystem. As in other subsystems, a joint backend design will be developed at the subsystem level. During Phase 1, Europe will concentrate on designing an advanced (2^{nd} generation) correlator that would exploit the latest in microelectronics capability. The U.S. will first build a correlator based on an existing design to be used in testing the two prototype antennas in a single-baseline interferometer configuration early in Phase 2. They will also design and do component development for a quarter-size (inputs from up to 32 antennas) correlator, based on current technology. The decision to proceed with either a scaled-up NRAO design or the European advanced correlator will be made early in Phase 2. Both sides will pursue development and testing of fiber optic signal transmission with emphasis of analog techniques in the U.S. and digital techniques in Europe.

3.5 Software, Controls, and Communications. Joint definition of the software and control requirements based on the scientific requirements and operational concept will be the first task. Following this, a joint top-level software, controls, and communications subsystem design plus joint definition of the development environment will be performed. Europe will then take the lead in defining the software engineering standards for the project. Once this common framework is agreed distributed development will proceed. In Phase 1 this will include development of the first increment of common software in Europe. The U.S. will take the lead in development of the software needed for evaluation and testing of the prototype antennas, both singly and as an interferometer.

3.6 Site. NRAO has already done a significant amount of site development planning and a first comprehensive cost estimate. This will continue as a joint activity with primary responsibility shifting over to ESO. The plan is to proceed through preparation of the bid packages that are expected to be one of the first major contracting activities of Phase 2. Negotiations with Chile to gain the necessary rights of access to the site will be a joint task led by ESO, as will geotechnical and environmental studies with ESO administering the study contracts. Europe will be responsible for operation and first-line maintenance of the site characterization equipment at Chajnantor. Analysis and interpretation of the site characterization data will be a joint task.

3.7 Management. Overall Phase 1 management and co-ordination will be a joint activity with each side managing their respective project tasks. The major task in the management area, in addition to managing the Phase 1 work, will be the complete programmatic definition of Phase 2, including the management structure, the detailed definition and division of work, and estimation of the cost to complete the full array. Operational analysis and planning of the construction activities and facilities will be an essential part of fully defining Phase 2.

4. Phase 1 Resource Allocations

Table 1 summarizes the allocation of resources for Phase 1. Part A is a summary of the currently proposed contributions of manpower and funds, both in-kind and in-cash. In addition to the five signatories of the European MoU, contributions have been proposed by institutions funded by the Research Councils of Sweden (SNSRC) and Italy (CNR). Due to the additional contributions from MPG, CNRS, SNSRC, and CNR, the amount of in-kind manpower shown in the table is almost double the amount committed in the European MoU. The in-kind manpower contributions of MPG and CNRS significantly exceed the projections given in Annex 6 of the European MoU. This is mostly due to a proposed contribution of 22.4 man-years from IRAM. Credit for this contribution of manpower has been assumed to be equally divided between MPG and CNRS.[1] The contributions of funds correspond to the projection of resource contributions given in Annex 6 of the European MoU,

[1] The contribution of IRAM manpower is still subject to approval by the IRAM Council, which meets on 17 June 1999.

except for the in-kind funds shown for MPG (190 KDM), for CNRS[2] (340 KDM), and for CNR (275 KDM), which have been proposed subsequent to the signing of the European MoU. As shown, the total of in-kind and in-cash funds, exclusive of in-kind contributions of personnel, is 17,224 KDM.

Table 1. Phase 1 Resource Summary

A. CONTRIBUTION SUMMARY

	IN-KIND (mn-yr)	IN-KIND (KDM)	IN-CASH (KDM)	
ESO	19.3	1593	7200	
PPARC	16.6	306	3000	
MPG	19.0	190	2000	
CNRS	22.5	340	2000	
NOVA/SR(	7.7	320		
SNSRC	16.2			
CNR	1.8	275		**Total KDM**
	103.1	3024	14200	17224

B. BUDGET SUMMARY

Area	Total Resources mn-yr	Total Resources KDM	Available in-kind mn-yr	Available in-kind KDM	Required in-cash including manpower mn-yr	Required in-cash including manpower cost(KDM)	other(KDM)	TOTAL
Science	14.0	186	11.4	186	2.6	465	0	465
Antenna	9.8	11400	5.8	0	4	600	11400	12000
Receiver	49.9	1640	46.1	1230	3.8	635	410	1045
Backend	16.4	500	14.6	75	1.8	301	425	726
Software	11.9	135	11.9	135	0			0
Site	11.2	590	8.2	590	3	420	0	420
Management	5.1	352	5.1	352	0			0
Total	118.3	14803	103.1	2568	15.2	2421	12235	14656

Part B is a summary of the budgets in each area. This table summarizes the more detailed spreadsheets for each area in the following subsections. The total man-years of effort planned is 118.3 mn-yr and the total funds budgeted, not including personnel cost, is 14,803 KDM. Of these totals, the projected in-kind contributions of manpower and funds are 103.1 mn-yr and 2,568 KDM. The balance of 15.2 mn-yr is projected to require 2,421 KDM of project in-cash contributions. Adding this to the balance of funds needed gives a total required in cash of 14,656 KDM. The total non-

[2] Not yet confirmed as an in-kind contribution.

personnel funds required (in-kind + in-cash) is 17,224 KDM, which equals the total funds contributed. 456 KDM of the 3,024 KDM of in-kind contributions of funds will be used to cover part of the in-cash manpower cost and keep the required in-cash contributions at 14,200 KDM.

4.1 Science & System. Table 2 provides a breakdown of the resources allocated to the Science & System area. The institutions participating in this area are listed along with the total resources from that institution (manpower and funds) to be expended. This total is broken down into what is available as an in-kind contribution and what needs to paid for with project in-cash contributions. The notation "to be determined" (TBD) in most cases means that the level of effort will be small fractions of several persons from the institution that will not be accounted for in detail. The resources for the UK Project Scientist, John Richer, are provided by PPARC, but not counted as part of their in-kind contribution. A final note that applies to all of these tables – when cash is required to pay for manpower (next-to-last column), the number below the total man-years is the cost in KDM. For example, in this case the 2.6 man-years of the EPS is projected to cost 465 KDM.

Table 2. Science & System Resource Breakdown

Area		Tasks	Institutions	Total Resources		Available in-kind		Required in-cash	
				mn-yr	KDM	mn-yr	KDM	mn-yr	KDM
Science &		European Project Scientist	IRAM	2.6				2.6	
System			ESO*	6.2	150	6.2	150		
			DEMIRM**	3.8		3.8			
			MPIfR	TBD					
			OSO	TBD					
			IRAM	TBD					
			CNR	TBD					
		Phase Calibration	MRAO	1.0	30	1.0	30		
		Array Configuration	ATC	0.5	6	0.5	6		
		UK Project Scientist	*MRAO****	*1.5*	*90*	*1.5*	*90*		
	*	plus 2 fellows		14.0	186	11.4	186	2.6	
	**	plus 1-2 thesis students						465	
	***	in addition to UK in-kind contribution							

4.2 Antenna Subsystem. Table 3 shows the resource allocation for antenna area. Essentially all of the resources come from Lund Observatory and are split between in-kind and in-cash. The TBD level of support from IRAM is expected to be small. The principal item is the prototype antenna contract. We will know the actual value of this contract in the timeframe of September 1999 and may have to adjust the allocation at that time.

Table 3. Antenna Resource Breakdown

Area		Tasks	Institutions	Total Resources		Available in-kind		Required in-cash	
				mn-yr	KDM	mn-yr	KDM	mn-yr	KDM
Antenna	Prototype Antenna		Lund	6.3	140	3.8		2.5	140
		Specification and tendering	IRAM	TBD					
		Procurement support							
		Contract technical management							
		Review and crosscheck contractor	Contract		11260				11260
		Monitor antenna installation							
		Antenna test and evaluation							
	Metrology studies and analysis		Lund	3.5		2		1.5	
				9.8	11400	5.8	0	4	11400
								600	

4.3 Receiver Subsystem. Table 4 shows the resource allocation for the receiver area. In this table the contributions from each institution are broken down to the major task groups. Within the task groups there is no correlation between the subtasks and the institutions on the same line, e.g., ATC/RAL will participate in optics design, cryostat design, and thermal modelling in the dewar group. SIS mixers and amplifier task group is an exception where each subtask is done by the institution on the same line.

Table 4. Receiver Resource Breakdown

Area		Tasks	Institutions	Total Resources		Available in-kind		Required in-cash	
				mn-yr	KDM	mn-yr	KDM	mn-yr	KDM
Receiver	Joint Receiver Subsystem Design		IRAM	0.5		0.5			
			NOVA/SRON	0.9	70	0.9			70
			RAL	0.9		0.9			
			OSO	0.5		0.5			
			DEMIRM	0.5		0.5			
	Dewar		IRAM	6		6			
		Design/build optics	ATC/RAL	1.35	45	1.35	45		
		Design/build cryostat	Arcetri		415		275		140
		Thermal modelling							
	SIS mixers and amplifiers								
		350 GHz mixer	OSO	4		4			
		650 GHz mixer	NOVA/SRON	6.8	320	6.8	320		
		700 GHz Finline mixer	MRAO	1.5	30	1.5	30		
		440 GHz mixer	DEMIRM	4	340	4	340		
		Backshort mixer	IRAM	2.9		2.9			
		IF amps	ETH/CAY	2.0 +		2.0 +			
	SIS junctions		IRAM	4		4			
		Production planning	OSO	3		1		2	
		Process development	DIMES	in NOVA/SRON above					
	Local oscillator		MPI/KOSMA	7.6	390	5.8	190	1.8	200
		Conventional LO	RAL/Cardiff	2.5	30	2.5	30		
		Photonic LO							
	Control and Test Electronics		MRAO	0.5		0.5			
		Control electronics	OSO	2.5		2.5			
		Automatic testing							
				50.0		46.2	1230	3.8	410
								635	

4.4 Backend Subsystem. Table 5 shows the resource allocation for the backend area. As in the receiver case, the contributions from each institution are broken down to the major task groups.

4.5 Software, Control, and Communications. Table 6 shows the resource allocation for the software, control, and communications area. As noted in the discussion of contributions above, the IRAM level of manpower is contingent on approval by the IRAM Council.

4.6 Site. Table 7 shows the resource allocation for site development and for site characterization. It should be noted that this does not include budget for development of an improved 183 GHz water line monitor. The work on radiometric phase calibration using existing 183 GHz radiometers may demonstrate the need for an improved radiometer. Should this be the case, the allocation will be re-examined later in Phase 1. OSO has proposed such a development using largely in-kind resources, but some cash would be required.

Table 5. Backend Resource Breakdown

Area		Tasks	Institutions	Total Resources		Available in-kind		Required in-cash	
				mn-yr	KDM	mn-yr	KDM	mn-yr	KDM
Backend	Joint backend subsystem design		NFRA	1.5	425			1.5	425
		Architectural concepts and analysis	AGSO	0.5		0.5			
		System verification and test study	NRAL	0.8	20	0.8	20		
		Data flow and on-line analysis study	Arcetri	0.8		0.8			
	ADC and FIR filters		AGSO	2.0		2.0			
		Study and development	MPIfR	1.0		1.0			
			RAL	0.7	25	0.7	25		
	Interconnections		IRAM +	4.0		4.0			
		Study and development	other FR						
	Correlator board design		NFRA	0.2				0.2	
		Study	NRAL	0.1		0.1			
			Arcetri	0.2		0.2			
	IF and signal conditioning		AGSO	0.6		0.6			
		Study	Arcetri	0.6		0.6			
	Signal transmission and distribution		NRAL	3.0	30	3.0	30		
		Study and development							
	IC technologies and design tools		Arcetri	0.2		0.2			
			RAL	0.2		0.2			
			NFRA	0.1				0.1	
				16.4	500	14.6	75	1.8	425
								301	

Table 6. Software, Control, and Communications Resource Breakdown

Area		Tasks	Institutions	Total Resources		Available in-kind		Required in-cash	
				mn-yr	KDM	mn-yr	KDM	mn-yr	KDM
Software	Science Software Requirements Definition		ESO	2.9	90	2.9	90		
			IRAM	5		5			
	Joint System-Level Design and Analysis		ATC/RAL/	3	45	3	45		
			MRAO						
	Software Engineering		MPIfR	1		1			
			OSO	TBD					
	Common Software Definition								
				11.9	135	11.9	135	0	

Table 7. Site Resource Breakdown

Area		Tasks	Institutions	Total Resources		Available in-kind		Required in-cash	
				mn-yr	KDM	mn-yr	KDM	mn-yr	KDM
Site	Site Development		ESO	4.3		2.8		1.5	
		Mining rights "insurance"			58		58		
		Preliminary geotechnical report			22		22		
		Full geotechnical testing and report			300		300		
		Environmental impact report			60		60		
	Site Characterization		OSO	3.9		2.4		1.5	
		Operations, maintenance, and	ESO	3	150	3	150		
		analysis							
				11.2	590	8.2	590	3	
								420	

4.7 Management. Table 8 shows the allocation to the management area. The general travel and meeting expenses budget covers this category of expenses from all areas of the project.

Table 8. Management Resource Breakdown

Area		Tasks	Institutions	Total Resources		Available in-kind		Required in-cash	
				mn-yr	KDM	mn-yr	KDM	mn-yr	KDM
Manage-		Project Manager/Administration	ESO	4.5	114	4.5	114		
ment		Deputy Project Manager	RAL	0.6	45	0.6	45		
		General travel/meeting expenses	ESO		193		193		
				5.1	352	5.1	352	0	

5. Phase 1 Schedule

The overall schedule for Phase 1 is shown in Figure 8 along with preliminary schedules for the project teams. Detailed schedules for each area of work have yet to be formulated.