

## F. Telescope Science Operations

### 1. North American ALMA Science Center

		FY07 Carryover		Total NSF New Funds (PRL) and Carryover	FTE (PRL)
		AST	New NSF Funds Budget (PRL)		
7.0	<b>ALMA Operations</b>				
7.1	NA ALMA Science Center		825,900	825,900	3.7
7.2	NA ARC total		604,300	604,300	5.1
7.3	Special Projects		422,100	422,100	-
7.4	NA ALMA Chilean Affairs		619,700	619,700	5.0
7.5	ALMA Technical Support		359,800	359,800	3.4
7.6	ALMA Development		-	-	-
7.7	NA Chile Operations	3,191,000	1,254,200	4,445,200	93.3
7.9	Directly Associated Costs (DAC)		360,000	360,000	-
	<b>Subtotal ALMA Operations</b>	<b>3,191,000</b>	<b>4,446,000</b>	<b>7,637,000</b>	<b>110.5</b>

The main goals of the North American ALMA Science Center (NAASC) for 2008 are to:

- Hire the two North American (NA<sub>m</sub>) Commissioning Liaison scientists and for all scientific staff to take part in commissioning activities at either the ATF in Socorro, NM or the OSF near San Pedro, Chile.
- Continue testing and exercising the major ALMA user software systems (observing tool, CASA offline reduction package, and pipeline) in order to generate user-friendly documentation and provide user support for early science.
- Support CASA development and a limited CASA release to ALMA advisory-committees (ASAC, ANASAC) and project personnel (Science IPT, European and East Asian ARCs).
- Complete the Memorandum of Understanding (MOU) with our Canadian partners.
- Continue to engage the NA<sub>m</sub> user community to keep it informed and ready for ALMA operations.
- Initiate a number of ALMA-related EPO activities.
- Support the office of Chilean affairs (a legal requirement for AUI/NRAO business in Chile).
- Support, in part, the UVa microfabrication lab and the ALMA spectral-line catalog.

The activities of all business units within the NAASC are described below.

The overall budget for this element is the one presented at the review of the NAASC Operations Plan on March 1, 2007. However, the costs of individual elements were changed by unanticipated activities (particularly in the areas of participation in CSV activities to train early for ALMA operations and earlier-than-anticipated user support for the CASA software system as it is released to our advisory committees, including two planned CASA tutorials). The cost of this additional scope is covered by the decision to delay hiring the first ALMA postdoc for one year.

## NAASC Operations and Full Science Support

This business unit supports North American (NA) ALMA operations outside the project-defined “core” elements, primarily regional community support beyond ALMA observing preparation and end-product use. Personnel include NAASC Head C. Carilli, a half share of a recent joint NRAO/UVa hire, a quarter share of astronomer Steve Myers, a fraction of business manager B. Porter to manage the NAASC budget, and a small fraction of NA Project Manager A. Russell for help with the NA ALMA Development effort and overall NA coordination. It also includes two FTEs for ALMA-specific EPO efforts conducted through the NRAO EPO office. C. Carilli runs the NAASC and responds to NSF, ALMA Board, and NRAO requests for input (presentations, reports, etc.). He leads the coordination effort with the Canadians, interacts with the larger NA scientific community, and coordinates efforts between ALMA and the rest of the NRAO (E2E, SAA, etc.). He also participates in ATF testing. S. Myers will interact with the CASA developers to make sure ALMA software requirements are properly prioritized in the development targets and that ALMA considerations are incorporated into the design of the user interfaces. His position is shared among the EVLA, ALMA construction, and ALMA operations. The joint NRAO/UVa hire will lead the NAASC Community Support programs (science workshops, schools, and postdoc programs).

The new MOU with our Canadian partners will define the guidelines and principles for the participation in ALMA operations by our Canadian colleagues. Mechanisms will be defined for annual consideration of the Canadian contribution to ALMA operations (nominally 7.25%). Some contributions will necessarily be cash (e.g. cost for Chilean Operations) and others could be in-kind (some aspects of ARC core support). Canadians are also eligible to propose for ALMA development funding.

The ANASAC remains the primary means of communication between the NAASC and the user community. At the August 2007 face-to-face meeting, the ANASAC considered three charges: (1) decide how to proceed with the ALMA “grants with observing time” program that the ANASAC previously endorsed, (2) review the ASAC and ANASAC “Terms of Reference” and recommend any changes, and (3) decide a topic and SOC (science organizing committee) membership for the next NAASC Science Workshop. We will act upon the ANASAC recommendations in the first part of FY 2008. The ANASAC will also provide input to the ASAC on charges from the ALMA board. The ANASAC holds telecons every second month and a face-to-face meeting every year.

The topic for the next NAASC workshop will be selected by the ANASAC, in consultation with the NAASC. This workshop will continue the highly successful series of scientific workshops begun in 2006 to promote and refine the scientific use of ALMA and eventually provide input to potential ALMA development projects.

Talks on ALMA status and ALMA science will be given at the AAS winter and summer meetings, the JWST meeting, and many U.S. and international institutions.

Most of the ALMA EPO effort is a prorated share of the NRAO EPO division, which represents ALMA at major meetings, produces the NRAO ALMA displays and brochures, publishes the NRAO Newsletter, and performs many other functions in which ALMA is represented along with other NRAO facilities (see the EPO section). A major milestone for this effort is hiring an ALMA EPO Officer. Unlike the other EPO staff, this Officer will be matrixed to the NAASC. We expect the ALMA EPO Officer to revamp the ALMA presence on the NRAO web pages, generate ALMA-specific content for the public, lead the production of a film documentary of the ALMA project, and coordinate EPO efforts within the larger international ALMA partnership.

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The total budget for this element in FY 2008 is \$826k. Apart from salaries, benefit, and travel (totaling \$497k for 3.7 FTEs), this provides \$152k for a prorated share of AUI Management, \$20k to support the yearly ANASAC face-to-face meeting, \$30k to support the NAASC Science Workshop and two CASA tutorials, and \$127k to support ALMA-specific EPO. The cost to support a fraction of Steve Myers' salary and two CASA tutorials was not anticipated at the March presentation of NAASC operations. We plan to cover this increased cost by delaying the recruitment of the first NAASC postdoctoral researcher by one year.

### **North American ALMA Regional Center (Core ALMA support)**

This business unit provides support for core ALMA operations, primarily those involving observing preparation, direct observing support (Astronomer On Duty in Chile and Quality Assurance), and post-observation support (offline software and archive). Staff include the ARC Manager (J. Hibbard), the ALMA CASA subsystem scientist (C. Brogan), a half-share of a planned joint NRAO/UVa research scientist, a fraction of an administrative assistant (J. Neighbours), and two scientists who will be recruited to serve as the ARC CSV (Commissioning and Science Verification) Liaison Scientists. The latter positions will be advertised in fall 2007 for employment starting in the second quarter of FY 2008.

A major task for the astronomers in this division is to take part in Commissioning and Science Verification as a means to train for ALMA operations, first at the ATF in Socorro and later at the OSF in Chile. All astronomers associated with the NAASC will participate in these activities along with members of the ALMA Science IPT. This level of support was not anticipated for FY 2008 in the original NAASC proposal. In particular, we had not anticipated ARC astronomers traveling to Chile for training before a three-element interferometer is working at the AOS. However, ARC participation in training as part of the Science IPT and commissioning team seems like a win-win situation, providing early training for NAASC staff and extra manpower that will help keep the ATF running for an additional nine months.

NAASC staff will also participate in scheduled tests of all major ALMA end-user software systems including:

- CASA offline software (lead scientist: C. Brogan).
- The ALMA ObsTool (lead scientist: J. Mangum from the Science IPT)
- The ALMA pipeline (lead scientist: J. Hibbard).
- The ALMA simulator (lead scientist: TBC)

Participation of NAASC staff in these tests is meant to ensure readiness of the software for early science and acquaint NAASC staff scientists with the use of the software so that they will be ready to provide user support and documentation. The pipeline and ObsTool will have 6-month test cycles through 2008. The CASA simulator is being developed on behest of NAASC staff, following advice from advisory committees and NAM astronomers at the NAASC Science Workshops. We expect it to be made available to the community in early 2008. At first the NAASC will provide a web-based form for users to enter their desired parameters and input images, and NAASC staff will run the simulator and post results for them. By the end of FY 2008 we plan to have a CASA-based task that users can run themselves.

The CASA offline software system is the software package for ALMA offline data reduction. CASA will have a limited beta release early in FY 2008. The NAASC decided to make this release available to its scientific advisory committees (ANASAC and ASAC) and to support the ALMA Science IPT and European and East Asian ARC scientists in its use. This task had not been anticipated and so was not included in the original NAASC operations plan. We plan to accomplish this task by helping support two CASA tutorials, one in the fall of 2007 and the other in the spring of 2008. The cost of these tutorials is

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included in WBS element 7.1 since it is outside the core ALMA support. NAASC staff will also respond to email queries from these designated beta users on the use of CASA and verify their submitted bugs. ARC personnel from other regions will participate in the tutorials but will then support regional use of CASA by their own advisory committees. The NAASC will conduct extensive tests of the CASA system each quarter, led by ALMA CASA subsystem scientist C. Brogan. CASA is scheduled for a second major release to a broader community by the end of FY 2008, and the NAASC will help generate a new version of the CASA cookbook prior to this release.

This business unit also includes the cost of the initial components for the ALMA Archive system, which must be in place by the start of interferometric commissioning in 2009. Although we had planned to use this money to buy archive hardware, the NRAO may outsource its archive(s) to another agency, in which case these funds would go to the outsourcing effort. The NRAO E2E division is actively investigating this issue, with a decision expected at least one year prior to the scheduled public release of commissioning data.

The total budget for this element in FY 2008 is \$666k. Apart from \$466k for salaries, benefits, and travel, this provides \$19k for relocation and starting costs for our new hires and \$181k for the initial installment of the NAM ALMA archive. Overall this work element is \$13k above the budget submitted in February 2007. It includes \$56k of additional duty travel to the ATF and OSF that was mostly offset by decreasing travel costs elsewhere in the budget. Our Canadian partners are expected to contribute to this effort, so the net cost of this element to the NSF is \$604k.

## **Special Projects**

This business unit supports work that is viewed by the NRAO as critical to ALMA's success, but that is not delineated in the AOP as part of the international operations functions. It includes two projects: SIS mixer development and creating a molecular and atomic spectral-line database. Both projects were described in the NAASC operations plan and received strong support from the review panel.

The international project has recognized that ALMA operations must support continuing R&D for SIS mixers. State-of-the-art SIS mixers are the key to the unprecedented sensitivities that will be achieved with ALMA receivers. Future developments in SIS mixer technology will bring substantial improvements to ALMA receivers, particularly for Bands 9 and 10. The Band 9 receiver being provided by the construction project will be a double-sideband system (not ideal for spectral-line identification), and only one SIS mixer ever built meets the demanding specifications for Band 10. Thus improving receivers for these bands is a high priority for the ALMA development program. The ultimate goal is a low-noise wide-band SIS mixer for 780–950 GHz ( $\lambda = 350 \mu\text{m}$ ).

Such upgrades and development and, of equal importance, the procurement of future components needed to repair SIS mixers in Bands 3 and 6 (as required of NAM deliverables), rely on the continued existence of SIS foundries. One of two existing SIS foundries in the U.S. is the University of Virginia Microfabrication Laboratory (UVML). The UVML has developed a very stable and repeatable process for making Nb-based SIS mixers and is a critical resource for U.S. astronomy and for ALMA. Even on the time scale of completion of ALMA construction, the closure of even one such facility would threaten future operations of ALMA. (The other foundry is the Jet Propulsion Laboratory Micro-fabrication Facility whose funding is threatened by recent NASA shifts in focus from Space Science towards Exploration.) The UVML represents a capital investment of order \$10M in research and test equipment plus many years of labor investment to set up and maintain a working facility and stable SIS mixer-fabrication process.

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During FY 2008 the UVML will continue development of Nb/AL-AIN/NbTiN SIS junctions. This contract work provides half support for research engineer A. Lichtenberger (a joint NRAO/UVa employee working in the UVML), full support for a UVA research scientist and graduate student, and includes funds for targets and substrates and clean-room time. At the NRAO Technology Center (NTC), test circuits will be designed and measured to determine the microwave properties of NbTiN, the design of an initial mixer circuit will be completed, LO and signal-source components will be bought and/or fabricated, and the LO signal optics will be designed.

Work continues on the Spectral Line Catalog (Splatalogue), which is now the world's most complete database of molecular transitions from mm to submm wavelengths. This database is critical to the full use of ALMA as a spectral-line instrument. In the coming year there will be a beta release of Splatalogue with increased functionality. It will include search filters, spectral-line "stick diagrams" having intensity units consistent with array or single-dish observations, and the ability to upload an existing spectrum and deduce a best fit to the data from the spectral-line parameters given in Splatalogue. NRAO scientist A. Remijan, supported by the Science IPT, will travel to universities and observatories operating instruments in the radio to submm regimes to demonstrate the functionality of and data present in Splatalogue. The NAASC will support these trips. Following his highly productive visit to the NAASC in FY 2007, Frank Lovas (NIST) will return in summer 2008 to further update the database.

The total budget for this element in FY 2008 is \$422k, which will provide \$384k contract support to the UVML, \$23k to the NTC for fabrication and testing of the signal optics and pre-amps, and \$15k for Splatalogue, to support travel for A. Remijan and summer salary for F. Lovas.

### **Chilean Affairs**

The NAASC will assume support of the Office of Chilean Affairs at the beginning of FY 2008. This small office in Santiago, Chile handles the legal and business affairs of AUI/NRAO, including representation of ALMA to the Republic of Chile for AUI and support for the JAO staff. This support consists of implementing actions initiated by the JAO, such as purchase orders, imports, pay orders, etc., and of assuming responsibilities for local ALMA Chilean staff. The office includes five staff members: a Scientist (E. Hardy) who acts as the official legal representative with the Republic of Chile, a secretary, and a staff of three in the fiscal/procurement office. This contingent supplements a staff of three NAM fiscal-support personnel supported directly by the JAO.

The total budget for this element in FY 2008 is \$668k. Apart from \$384k for salaries, benefits, and travel, this provides \$284k for facility support of the Santiago office. Our Canadian partners are expected to contribute to this effort, so the net cost of this element to the NSF is \$620k.

### **ALMA Technical Support**

This business unit provides technical support to the ALMA observatory. Currently this is only support for the ALMA-specific development of the CASA offline software system. The NAASC shares this support with the EVLA, with the NAASC share accounting for 3.3 FTEs of effort from seven scientific programmers and software developers. It includes the development effort needed for CASA tutorials and user support, CASA tests, and the CASA ALMA simulator.

The total budget for this element in FY 2008 is \$397k, which covers salaries, benefits, and travel. Our Canadian partners are expected to contribute to this effort, so the net cost of this element to the NSF is \$360k.

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## ALMA Development Support

This business unit will support North American development. No activity is planned for FY 2008 beyond input into long-range ALMA development via the yearly NAASC science workshop.

## Chilean Operations

The largest NAASC budget element is for the NAM fraction of the operations costs of the Joint ALMA Observatory (JAO) in Chile. The JAO operations costs are described in the ALMA Operations Plan version C (AOPvC) presented to an international review panel in February 2007 and reviewed by the NAM review panel along with the NAASC operations plan.

The JAO budget is reviewed annually by the ALMA Board. The next review will not occur until October 2007, so we use the budget presented in the AOPvC and assume a linear spending profile to convert from calendar years (used by the AOPvC) to U.S. fiscal years. The NAM portion of the CY 2008 JAO budget includes \$3.2M in running costs (primarily for operations of the OSF facility and the NAM share of payments to Chile), \$5.3M for staffing costs (a prorated portion of the international staff plus all of the local staff hires, a total of 93.3 FTEs, and an offset of \$2.5M from the East Asian partnership, for a total CY 2008 budget of \$6,046k. The CY 2007Q4 JAO budget is projected to be \$258k, resulting in a total budget for the NAM share of Chilean Operations of \$4,792k in FY 2008. The Canadians are expected to contribute 7.25% of this cost, resulting in a cost to the NSF of \$4,445k.

## Directly Associated Costs (DAC)

This business unit covers Directly Associated Costs. These are a prorated share of costs and activities performed in other NRAO divisions on behalf of NAASC personnel. These include IT support, facilities support (library and building lease and maintenance), business and HR support, and certain activities performed by the Director's office, SAA, and the E2E division. The amount is prorated by the number of NAASC staff and is \$360k in FY 2008.

### NAASC Milestones FY 2008

	Item	Delivery Date
1.	New MOU with Canada for ALMA operations	10/15/07
2.	CASA beta release	10/15/07
3.	Advertise for Scientist 4 (CSV liaison)	10/15/07
4.	Advertise for Scientist 5 (CSV liaison)	10/15/07
5.	ARC participation in AIV/CSV to train for operations (ATF trips)	10/15/07
6.	CASA tutorials for beta testers (Socorro)	10/16/07
7.	Participate in Pipeline Test 5	11/01/07
8.	Science center visits – Herschel	11/19/07
9.	SIS: First measurements of NbTiN properties	12/07/07
10.	Spectral-line catalog—beta release	12/31/07
11.	First ALMA postdoc	01/01/09
12.	Release CASA ALMA simulator to community (web-based form)	01/01/08
13.	Participate in ObsTool Test 6	02/24/08
14.	ARC CASA testing Q1	03/01/08

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	<b>Item</b>	<b>Delivery Date</b>
15.	SIS: Complete initial mixer design for $\lambda = 350 \mu\text{m}$ mixer	03/08/08
16.	SIS: Design $\lambda = 350 \mu\text{m}$ optics	03/08/08
17.	Start NAM development planning	04/01/08
18.	CASA tutorials for beta testers	04/01/08
19.	New ALMA EPO hire	04/01/07
20.	Advertise for Scientist 6 (CASA)	04/07/08
21.	Hire Scientist 4 (CSV liaison)	04/08/08
22.	Hire Scientist 5 (CSV liaison)	04/08/08
23.	Participate in Pipeline Test 6	05/01/08
24.	Decision on NAM ALMA archive—buy or outsource	05/07/08
25.	ARC participation in AIV/CSV to train for operations (OSF trips)	05/08/08
26.	3rd NAASC Science workshop	05/22/08
27.	ARC CASA testing Q2	06/01/08
28.	Advertise for Archive Tech 1	06/07/08
29.	SIS: Complete $\lambda = 350 \mu\text{m}$ signal and LO sources	06/08/08
30.	2nd release of CASA ALMA simulator to community (CASA task)	07/01/08
31.	Visit by F. Lovas to help resolve molecular species for Splatatalogue	07/01/08
32.	ANASAC Face-to-Face meeting	08/17/08
33.	Participate in ObsTool Test 7	08/24/08
34.	ARC CASA testing prior to release 2	09/01/08
35.	Offline Cookbook, version 2	10/01/08
36.	CASA release 2	10/01/08