

## 14 SCHEDULE AND BUDGET

### Revision History

2001-Nov-08: Initial release, Budget and Schedule from EVLA Management Plan, September 2001  
 2002-May-31: Updated budget section to be current as of Q2 2002  
 2003-Aug-16: Updated budget and schedule to be current as of Q3 2003  
 2004-Dec-04: Updated budget and schedule to be current as of Q4 2004  
 2006-Apr-03: Updated budget and schedule to be current as of Q1 2006

### 14.1 Introduction

In this chapter a brief summary of the schedule and budget information for the project is provided. This information will change as the project progresses, so readers should understand that the information provided is current as of the date identified in the Revision History above. If required, a more up-to-date or more detailed version of this information can be requested from EVLA Project Management.

### 14.2 Project Work Breakdown Structure (WBS)

The EVLA Project is the 6<sup>th</sup> activity within NRAO's overall WBS. The work of the EVLA is subdivided into the 12 principal Level 2 tasks shown in Table 12.1.

**Table 14.1 EVLA Project WBS Level 2 tasks**

WBS No.	Task Name	Task Description
6.01	Project Management	Project management including work definition, budget and schedule control. Advisory committee, design review and oversight activities.
6.02	System Integration and Testing	All system engineering activities during the design, integration, installation and test phases of the project. Management of the technical aspects of both the hardware and software systems. Provision of shared systems such as modules, racks and power supplies.
6.03	Civil Construction	Burial of the long-distance fiber optics cables along the arms of the array. Construction of a new shielded room to house the new EVLA correlator.
6.04	Antennas	Structural modifications to the VLA feed support structure on the antennas to allow installation of the new feed and receiver systems. Modifications to the vertex rooms on the antennas to allow installation of the new electronic systems.
6.05	Front End Systems	Design, construction and installation of all feeds and receivers for the eight EVLA receiver bands. Includes conversion to first IF at 8-12 GHz. Modifications to the cryogenics systems on the antennas for compatibility with the new receivers.
6.06	Local Oscillator System	Provision of a central reference oscillator system and an antenna remote local oscillator (LO) system. Provision of a "round-trip-phase" monitoring system to measure the phase of the LO at each antenna.
6.07	Fiber Optic System	Provision of all fiber optics systems including the fiber, the optical transmitters and the optical receivers for LO distribution, IF transmission and M/C.

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6.08	Intermediate Frequency System	Provision of all frequency converters required to convert the signal from the 8-12 GHz band at the output of each receiver to the 2-4 GHz baseband input to the digitizers. Provision of the wide band and narrow band digitizers. Provision of switching equipment required to direct the desired IF into each of the digitizers.
6.09	Correlator	Construction and installation of the EVLA correlator, supplied by Canada, and NRAO interfaces.
6.10	Monitor and Control System	Provision of hardware and software for array monitor and control. Includes both the central computer system and the electronics system located in each module for interface to the M/C system.
6.11	Data Management and Computing	Provision of software and hardware for observation preparation and scheduling and for post-correlation data processing. Includes a pipeline system for rapid image formation.
6.12	Education and Public Outreach	EVLA contribution to NRAO's EPO program.

A listing of the detailed Level 3 and Level 4 tasks in the WBS is available at <http://www.nrao.edu/evla/admin/wbs/wbssumm.pdf>

### 14.3 Project Schedule

The new EVLA equipment required for the antennas was designed and prototyped during 2002, 2003 and 2004. This prototype system began to be installed on the EVLA Test Antenna (VLA antenna 13) in Q3 of 2003, with more equipment being added over the following months as designs were completed or modified. This initial prototype system consisted of the new LO, IF, and fiber optics systems, the new feed cone, and some of the new feed/receiver designs. Old feeds and receivers were used where necessary to provide frequency coverage. Also, hardware for the new Monitor and Control (M&C) system and the new M&C software were included to allow the EVLA Test Antenna to be operated with the rest of the VLA. Using this prototype equipment, first light was recorded with the Test Antenna in October 2003, and first interferometric fringes were obtained in March, 2004. An improved prototype system was installed on the second EVLA antenna (VLA antenna 14) in late 2004, and first fringes were obtained between this antenna and the rest of the VLA (including antenna 13) in September 2004. A "production-like" electronics system, in which most of the problems found in prototyping have been fixed, was installed on Antenna 14 in January 2005. The EVLA overhaul of antennas 16 and 18 followed.

The project schedule was delayed in 2005. One reason for the delay was the need to redesign the digital transmission system (DTS). The redesign was complete in June 2005. Another reason for the delay was the decision in mid-2005 to suspend EVLA antenna overhauls in order to allow project staff to focus on outstanding design issues and testing and debugging activities. By December 2005, sufficient progress was made in these areas so that EVLA antenna overhauls resumed with the fifth EVLA antenna (VLA antenna 24).

Currently, antennas 13, 14, and 16 have all 4-IF bands working. Overhauls on antennas 18 and 24 are complete, and the 4-IF bands should be working on these antennas in May 2006. Antenna 26 was recently brought into the antenna assembly building for its overhaul.

The project plan is to have 5 antennas equipped with EVLA electronics by the end of FY 2006 (September 2006). Antennas will then be overhauled at a rate of about 5.5 antennas per year. The last antenna is scheduled for retrofit by Q3 of 2010. The new receivers will be installed at a slower rate than this, with the last receiver planned for installation in Q2 of 2012.

The correlator is being designed and built at the Herzberg Institute of Astrophysics in Canada and will be installed in a new correlator room in the VLA control building. The new correlator room is nearly complete. A small 3 or 4 antenna prototype of a subset of the correlator will be tested using astronomical observations at the

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VLA in Q3 of 2007, and first testing of the first subset of the final correlator will begin in Q3 of 2008. Full correlator commissioning is planned to be complete in Q3 of 2009.

The software for the new monitor and control system is scheduled so as to provide the level of support required for the various phases of hardware delivery described above. This includes support for VLA observations using transition hardware, tests of the prototype correlator in Q3 of 2007, tests of the final correlator beginning in Q3 of 2008, and then early science with a subset of the correlator. Similarly, new data management software will be available as required to handle the data from the new correlator.

The summary project schedule for all parts of the project, required to support the schedule goals listed above, is presented below.

EVLA PROJECT MASTER SCHEDULE

As of March 31, 2006

ID	WBS	Task Name	Start	Finish	% Complete	2006				2007				2008				2009				2010				2011				2012			
						Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
1	1	<b>Project Management</b>	5/1/01	6/1/12	78%																												
1	1.1	Management/Subsystem Engineering	5/1/01	7/6/09	92%																												
8	1.1.20	Management Plan	5/21/01	8/9/02	100%																												
17	1.1.21	Project Management & Tracking	10/5/01	7/6/09	83%																												
27	1.1.40	Key Milestones	11/4/02	6/1/12	0%																												
42	1.6	Project Book	6/4/01	3/1/02	100%																												
47	1.10	Office Equipment & Supplies	6/4/01	6/23/06	93%																												
51	1.20	Advisory Committee	10/15/01	9/11/08	61%																												
2	2	<b>System Integration &amp; Testing</b>	5/1/01	4/30/10	83%																												
1	2.1	Management/Subsystem Engineering	5/1/01	6/1/07	82%																												
12	2.1.30	System CDRs & analysis	5/19/04	11/14/06	50%																												
20	2.1.50	Test Antenna Plan	10/14/02	9/14/06	87%																												
22	2.1.50.2	Hardware Bench Integration	1/6/03	7/10/06	80%																												
27	2.1.50.5	1st Test Antenna Outfit	4/14/03	6/3/04	100%																												
32	2.1.50.10	System Tests on Antenna	5/13/03	9/14/06	81%																												
47	2.1.60	System Performance & Testing	4/15/05	4/28/06	0%																												
53	2.5	Test and Lab Equipment	5/1/01	11/8/07	99%																												
59	2.10.1	Power Supply System	9/3/02	10/31/08	92%																												
73	2.10.28	P302 Power Supply	8/8/05	10/27/05	100%																												
78	2.10.30	P351 Power Supply	12/5/05	7/11/06	0%																												
85	2.15	Site RFI characterization & Suppression	4/9/02	4/17/06	78%																												
90	2.15.15.1	RFI/EM Analysis of electronics & computers	7/16/02	4/17/06	57%																												
94	2.16	External RFI & Systems Immunity	4/22/02	10/16/09	99%																												
96	2.16.10	EVLA antenna sidelobe gain patterns 2-120	3/31/06	10/16/09	0%																												
109	2.20	Scientific Support	4/9/02	11/6/02	100%																												
112	2.25	Modules Bins & Racks	2/1/02	10/28/08	71%																												
116	2.25.10	Prototype module, bin & rack assembly	6/17/02	3/1/05	100%																												
130	2.25.30	Module Parts Production	2/9/04	10/28/08	32%																												
139	2.30	Transition Planning	12/19/03	4/30/10	32%																												
146	2.30.17	EVLA Transition Planning	1/13/05	4/30/10	0%																												
3	3	<b>Civil Construction</b>	6/4/01	11/1/07	89%																												
1	3.1	Management/Subsystem Engineering	6/4/01	11/1/07	94%																												
8	3.5	Fiber Optic Cable	1/2/02	2/6/04	99%																												
21	3.5.5	Trench & install FO cable (200kft)	2/14/02	2/13/04	100%																												
23	3.5.5.10	West Arm	10/30/02	5/1/03	100%																												
33	3.5.5.30	East Arm	4/11/03	9/9/03	100%																												
43	3.5.5.50	North Arm	4/11/03	1/30/04	100%																												
55	3.10	New Correlator Room	12/14/01	11/21/06	88%																												
66	3.10.5	Shielded Room	10/3/05	11/21/06	56%																												
72	3.10.10	Remodeling	12/19/02	6/7/06	86%																												
88	3.10.15	RFI Shielded Test Chamber	12/14/01	4/1/02	100%																												
93	3.15	CB HVAC	8/25/03	10/9/06	63%																												
103	3.20	Power Distribution	1/6/03	11/1/07	72%																												
4	4	<b>Antennas</b>	5/1/01	4/14/11	62%																												

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Task Baseline Baseline Milestone Baseline Summary Split

Progress Milestone Summary

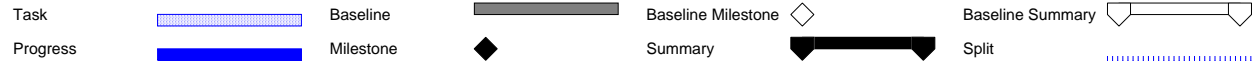


EVLA PROJECT MASTER SCHEDULE

As of March 31, 2006

ID	WBS	Task Name	Start	Finish	% Complete	2006				2007				2008				2009				2010				2011				2012										
						Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4						
761	5.4.6	Compressors & Helium Lines	3/4/03	8/18/09	87%																																			
769	5.4.7	Refrigerators	5/5/03	9/9/09	47%																																			
6	6	<b>LO/IF</b>	<b>6/4/01</b>	<b>11/23/10</b>	<b>58%</b>																																			
1	6.1	Management/Subsystem Engineering	6/4/01	3/1/10	95%																																			
12	6.5	Master LO System	11/12/01	8/31/06	91%																																			
15	6.5.10	L351- 512MHz Offset Generator	6/10/02	8/2/06	83%																																			
29	6.5.25	L350 Central Reference Generator	6/3/02	11/14/05	100%																																			
42	6.5.30	L354 Central Reference Distributor	12/15/03	12/13/05	100%																																			
53	6.5.31.5	L355 Digital Timing Distributor	6/30/05	12/21/05	100%																																			
62	6.7	Central Antenna System	1/21/02	3/4/08	59%																																			
64	6.7.5	L352 RTP Measurement	7/15/02	12/1/05	100%																																			
80	6.7.5.15	L352 RTP Hardware Production	12/15/05	10/12/07	4%																																			
88	6.7.10	L353 LO Transmitter Module	1/21/02	3/4/08	58%																																			
105	6.10	L301 12-20 GHz Synthesizer	8/27/01	11/13/08	56%																																			
123	6.10.20	L301 Synthesizer Hardware Production	8/25/04	11/13/08	17%																																			
133	6.15	L302 10.8-14.8 GHz synthesizer	10/29/01	3/19/09	54%																																			
149	6.15.20	L302 Synthesizer Hardware Production	8/25/04	3/19/09	27%																																			
158	6.15.22	L300 Synthesizer Reference Generator	3/7/05	3/1/07	40%																																			
165	6.20.1	Antenna Reference System	11/5/01	12/8/08	49%																																			
167	6.20.5	L304 Reference Receiver	4/22/02	1/18/08	52%																																			
185	6.20.10	L305 Reference Generator/Distributor	9/20/02	12/8/08	46%																																			
208	6.25	Antenna Outfitting	8/12/03	11/23/10	29%																																			
222	8.0	Band/LO Switches & Converters	11/19/01	3/1/10	79%																																			
223	8.5	Band Switches	5/5/03	10/1/09	99%																																			
235	8.10	4/P & L/S/C Converter Modules	1/28/02	6/1/06	94%																																			
258	8.15.15	T303 U/X-band Converter	7/15/02	2/12/08	56%																																			
281	8.15.20	T301 & 302 Converter Production	4/3/06	10/1/09	0%																																			
289	8.20	Base Band Converters	11/19/01	3/1/10	92%																																			
7	7	<b>Fiber Optics</b>	<b>6/4/01</b>	<b>8/10/10</b>	<b>68%</b>																																			
1	7.1	Management/Subsystem Engineering	6/4/01	8/10/10	99%																																			
14	7.5	IF Fiber System	3/18/02	6/30/09	78%																																			
15	7.5.5	Formatter	3/18/02	3/31/06	99%																																			
35	7.5.10	Deformatter	4/8/02	5/21/08	59%																																			
52	7.5.15	Laser Transmitter	11/1/02	12/15/05	100%																																			
65	7.5.20	IF Interface	6/18/02	6/30/09	99%																																			
74	7.5.25	IF System Production	4/12/04	1/14/09	0%																																			
82	7.10	Fiber Infrastructure & Antennas	10/17/01	8/10/10	59%																																			
83	7.10.5	Fiber Infrastructure	10/17/01	7/13/07	76%																																			
148	7.10.10	Antenna Fiber	9/30/02	8/10/10	43%																																			
178	7.15	Samplers & MCB	3/1/02	1/14/09	59%																																			
179	7.15.5	Monitor & Control	3/1/02	4/8/05	100%																																			
195	7.15.10	2-4 GHz Sampler 3-Bit	4/19/02	1/14/09	37%																																			
214	7.15.15	1 GHz Sampler 8-Bit	3/4/02	12/26/07	49%																																			
231	7.20.10	LO Transmitter Module - L353	1/21/02	4/9/08	55%																																			

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ID	WBS	Task Name	Start	Finish	% Complete	2006				2007				2008				2009				2010				2011				2012			
						Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
8	10	<b>Monitor &amp; Control</b>	<b>5/1/01</b>	<b>5/19/10</b>	<b>60%</b>																												
1	10.1	Management/Subsystem Engineering	6/5/01	6/6/06	91%																												
16	10.5	M&C Electronic Hardware	1/14/02	10/8/07	70%																												
17	10.5.5	Physical Interface	1/14/02	10/8/07	59%																												
45	10.5.10	Utility Module - M302, M303	11/24/03	4/28/06	85%																												
52	10.5.15	Front End Interface Module - F317	8/1/03	4/21/06	98%																												
60	10.5.16	Analog boards	1/10/05	7/20/06	39%																												
65	10.30	Transition Module - F320	1/2/03	8/17/05	100%																												
72	10.32	MIB Slot Identification	1/27/04	5/1/06	89%																												
81	10.32	Converter Interface - M301	6/2/03	5/8/06	93%																												
88	10.10	M&C Network Hardware/ Software	12/3/01	4/30/07	94%																												
102	10.15	M&C Computing Systems, Hardware & Software	5/1/01	5/8/06	96%																												
116	10.15.20	MIB prototype board, design & dev	5/1/01	9/18/03	100%																												
129	10.20	M&C EVLA Software	5/1/01	5/19/10	40%																												
130	10.20.5	Stabilization of the VLA	5/1/01	6/10/04	100%																												
139	10.20.10	Requirements (High Level, Raw)	10/5/01	6/26/02	100%																												
153	10.20.15	High Level Sftwre Arch & Design	1/4/02	4/28/06	98%																												
171	10.20.25	Mid-Level Analysis & Design	1/8/02	4/8/09	22%																												
214	10.20.35	Detailed Design & Coding	10/5/01	5/19/10	25%																												
9	11	<b>Data Management</b>	<b>10/1/01</b>	<b>8/27/10</b>	<b>62%</b>																												
1	11.1	e2e Project	10/1/01	8/27/10	62%																												
2	11.1.1	Management and Project Book	12/3/01	6/9/04	100%																												
10	11.1.2	Infrastructure	1/6/03	9/12/06	59%																												
14	11.1.3	Proposal submission toolkit	9/16/02	5/11/05	100%																												
21	11.1.7	Observation scheduling toolkit	3/31/03	5/26/06	20%																												
24	11.1.8	Pipeline toolkit	4/1/02	6/8/07	29%																												
30	11.1.10	Archive toolkit	10/1/01	3/24/05	100%																												
38	11.1.11	Calibration toolkit	4/1/02	3/3/03	100%																												
44	11.1.12	Master Address List	4/3/06	10/13/06	0%																												
50	11.1.13	Transition Plan	3/21/05	8/27/10	0%																												

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Task Baseline Baseline Milestone Baseline Summary Split

Progress Milestone Milestone Summary Split

## **14.4 Project Budget**

The current project budget is shown in the Project Cost Summary below. All funds are given in US\$(FY2006). The project funding will come from 4 sources: \$56.3 M from new NSF funds, \$15.8M in manpower provided by the NRAO operations budget, approximately \$14.7M funded by the Canadian government for the correlator, and \$1.75M from the Mexican government.

In early 2005, the Mexican CONACyT issued a contract to NRAO for the construction of equipment that included complete sets of electronics for two EVLA antennas and K and Q band receivers. The equipment has been built. The total Mexican funding of \$1.75M was received and deposited into the NRAO EVLA account.

The project budget was revised in early FY 2005 to accommodate additional requirements that were not anticipated in the original EVLA proposal. Additional charges include compensation for an overrun in contributed effort from the operations budget (\$800K), compensation for AIPS++ personnel (\$1.4M), and a charge for 10 FTE-years of e2e programming effort (\$1M). All charges were taken from project contingency.



WBS	Task Name	Actual 2001	Actual 2002	Actual 2003	Actual 2004	Actual 2005	Budget 2006	2007	2008	2009	2010	2011	2012	Totals
6.01	Project Management	77.0	175.4	119.8	277.8	148.1	246.7	215.2	250.8	311.5	362.1	156.4	0.0	2340
6.02	System Integration & Testing	212.0	478.0	236.4	746.1	571.2	339.2	390.4	394.3	227.3	0.0	0.0	0.0	3595
6.03	Civil Construction	0.2	252.0	40.1	229.0	197.4	330.3	0.0	93.0	0.0	0.0	0.0	0.0	1142
6.04	Antennas	0.0	46.7	98.5	497.2	172.3	138.4	69.2	77.6	38.8	26.6	0.0	0.0	1165
6.05	Front End Systems	385.5	114.6	596.5	1312.8	1894.2	1408.1	861.0	923.6	1300.8	1351.3	213.0	0.0	10362
6.06	Local Oscillator System	14.1	292.4	253.0	1188.4	357.9	299.3	238.2	189.5	220.2	156.6	0.0	0.0	3210
6.07	Fiber Optic System	4.7	603.8	735.5	1175.6	685.8	784.7	1119.5	601.7	430.3	167.0	0.0	0.0	6309
6.08	Intermediate Frequency System	0.0	105.5	327.5	215.4	819.9	446.8	423.5	459.2	384.0	56.2	0.0	0.0	3238
6.09	Correlator	149.0	362.0	155.0	618.0	37.0	4281.5	1879.0	45.0	17.0	0.0	0.0	0.0	7544
6.10	Monitor & Control System	0.0	209.2	255.8	367.0	540.8	783.1	291.7	314.5	285.1	249.2	0.0	0.0	3296
6.11	Data Management & Computing	2.8	0.2	219.1	180.8	37.2	51.4	28.7	206.0	602.0	2.0	2.0	0.0	1332
6.12	Education & Public Outreach	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
	M&S Total	845	2640	3037	6808	5465	9109	5516	3555	3817	2371	371	0	43533
	Travel	7	93	72	76	109	134	84	62	56	32	0	0	727
	Direct Labor	126	1115	1689	2297	3066	2828	2689	2117	1846	645	132	0	18549
	NRAO Indirect Labor	195	1549	2317	2186	1891	1656	1672	1808	1538	443	368	228	15851
	NRAO Wages & Benefits	321	2664	4006	4483	4957	4484	4361	3925	3383	1088	500	228	34400
	Canadian Labor	54	414	671	533	523	438	499	321	136	0	0	0	3589
	Sub Total	1228	5810	7787	11901	11054	14165	10460	7863	7393	3491	872	228	82248
	Contingency	0	0	0	0	0	0	0	451	0	2376	0	0	2827
	Redirected NRAO Effort	-195	-1549	-2317	-2186	-1891	-1656	-1672	-1808	-1538	-443	-368	-228	-15851
	Canadian Contribution	-203	-776	-826	-1151	-560	-4720	-2378	-366	-153	0	0	0	-11133
	Mexican Contribution						-1747							-1747
	EVLA Project Funds	830	3486	4643	8563	8603	6043	6410	6140	5702	5424	503	0	56345
	Carryover to next yr	2170	3685	4363	5140	1880	1277	433						
	Carryover from prior yr		-2170	-3685	-4363	-5140	-1880	-1277	-433				0	
	NSF Funded	3000	5000	5322	9340	5340	5440	5566	5707	5702	5424	503	0	56345
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Totals