Quarter Status Update (QSU) July – September FY 2009

December 16, 2009

Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array

Agenda

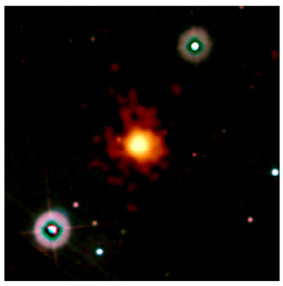
- Science Results
- Metrics
- Observatory Science Operations
- Site Specific Activities
  - ALMA
  - VLA/EVLA
  - GBT
  - VLBA
- Observatory-wide Operations

The format followed on this agenda provides orientation to the structure of this briefing, gives some high level science results and metrics, and then reviews Observatory Science Operations, Site Specific Activities, and then Observatory-wide operations.

VLA Science Results (I)

Discovery of the Radio Afterglow from the Most Distant Cosmic Explosion

- Gamma Ray Burst source GRB 090423 has redshift z = 8.3
- This GRB is the most distant known object in the Universe
- Radio afterglow detected by the VLA; data combined with X-ray and IR data
- No conclusive evidence was found to identify the GRB progenitor as a Population III star



GRB 090423

NRAO

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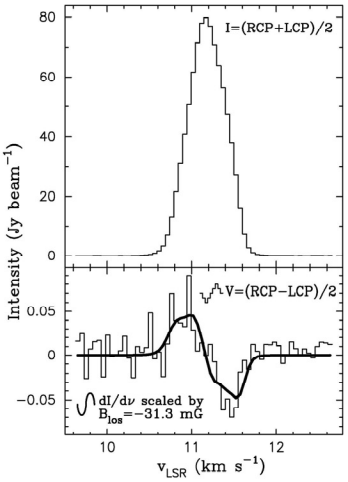
Investigators: P. Chandra (RMC, Canada); D. Frail (NRAO); D. Fox (PSU); S. Kulkarni (Caltech); E. Berger (Harvard); S. B. Cenko (UC Berkeley); F. Harrison (PSU); M. Kasliwal (PSU)

VLA Science Results (II)

First Detection of the Zeeman Effect in a 36 GHz Methanol Maser

- New science capabilities have already been enabled by the EVLA 26-40 GHz receivers
  - Total of 15 now installed
- First detection of the Zeeman effect in 36 GHz methanol maser
  - Star-forming region M8E
  - Line of sight magnetic field: B_{los} = 31mG
  - Field is dynamically significant



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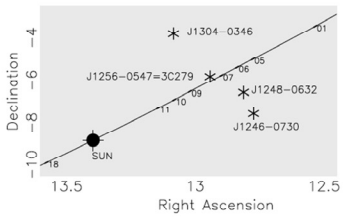
Investigators: A. P. Sarma (DePaul) and E. Momjian (NRAO)

Ap. J. (Letters) in press

VLBA Science Results

Progress in Measurements of the Gravitational Bending of Radio Waves Using the VLBA

- VLBA used at 43, 23, and 15 GHz to measure gravitational bending of 4 radio sources by the Sun
- Independent measurement of PPN γ parameter
- Separate systematic errors compared to earlier measurements
- Measure $\gamma = 0.9998 \pm 0.0003$ (68% confidence level)
- Agreement with GR prediction $\gamma = 1$
- Further improvements to method by factor of ~ 4 possible



Solar path with background sources

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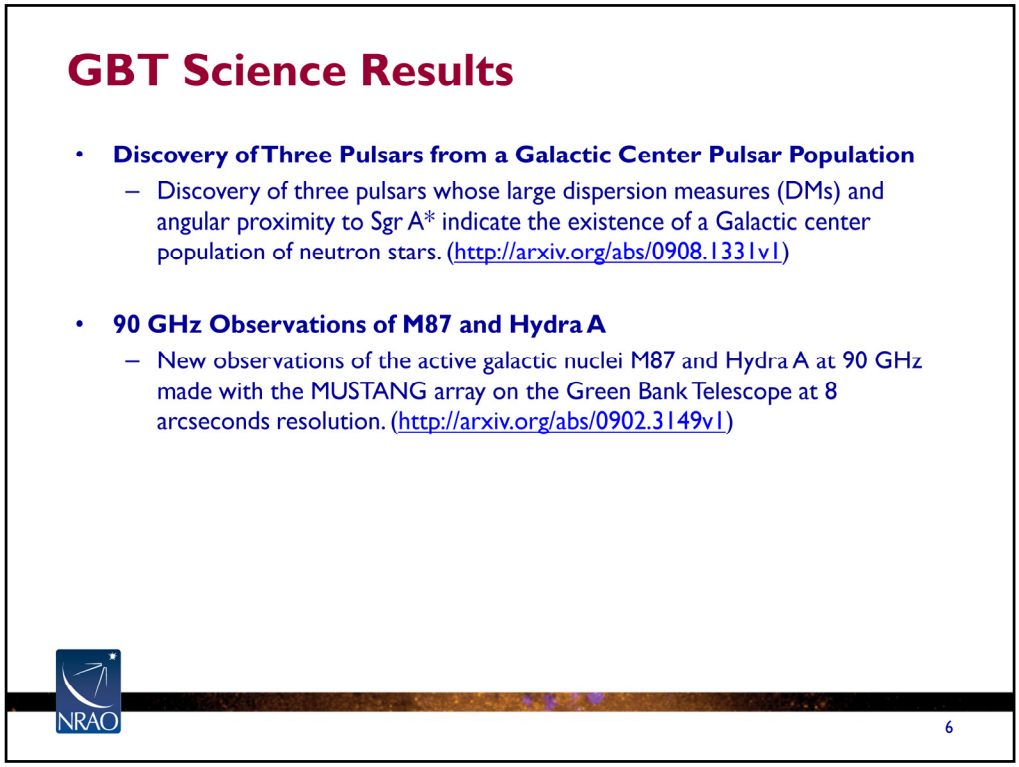
Investigators: E. Fomalont (NRAO), S. Kopeikin (Missouri), G. Lanyi (JPL), J. Benson (NRAO)

Other measurements of γ have claimed somewhat higher precisions than this result, but there have been questions about the magnitude of their systematic errors. This approach does not suffer from those errors, and produces a total error of a few parts in ten thousand. Published in Ap.J. 699, 1395 (2009)



Discovery of Three Pulsars from a Galactic Center Pulsar Population

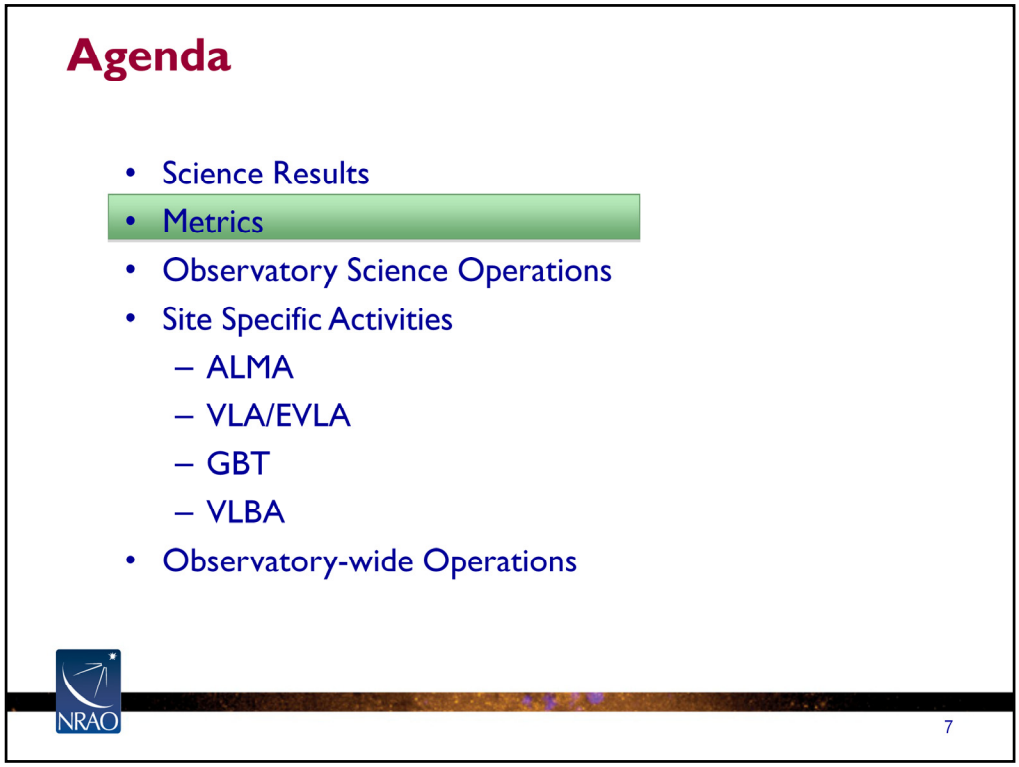
Investigators: Deneva, J. S.; Cordes, J. M.; Lazio, T. J. W.

We report the discovery of three pulsars whose large dispersion measures (DMs) and angular proximity to Sgr A* indicate the existence of a Galactic center population of neutron stars. The relatively long periods (0.98-1.48 s) most likely reflect strong selection against short-period pulsars from radio-wave scattering at the observation frequency of 2 GHz used in our survey with the Green Bank Telescope. One object (PSR J1746–2850I) has a characteristic spindown age of only 13 kyr along with a high surface magnetic field ~4 × 1013 G. It and a second object found in the same telescope pointing, PSR J1746–2850II (which has the highest known DM among pulsars), may have originated from recent star formation in the Arches or Quintuplet clusters given their angular locations. Along with a third object, PSR J1745–2910, and two similar high-dispersion, long-period pulsars reported by Johnston et al., the five objects found so far are 10-15 arcmin from Sgr A*, consistent with there being a large pulsar population in the Galactic center, most of whose members are undetectable in relatively low-frequency surveys because of pulse broadening from the same scattering volume that angularly broadens Sgr A* and OH/IR masers.

90 GHz Observations of M87 and Hydra A

Investigators: Cotton, W. D.; Mason, B. S.; Dicker, S. R.; Korngut, P. M.; Devlin, M. J.; Aquirre, J.; Benford, D. J.; Moseley, S. H.; Staguhn, J. G.; Irwin, K. D.; Ade, P.

This paper presents new observations of the active galactic nuclei M87 and Hydra A at 90 GHz made with the MUSTANG array on the Green Bank Telescope at 8 arcseconds resolution. A spectral analysis is performed combining this new data and archival VLA7 data on these objects at longer wavelengths. This analysis can detect variations in spectral index and curvature expected from energy losses in the radiating particles. M87 shows only weak evidence for steepening of the spectrum along the jet suggesting either re-acceleration of the relativistic particles in the jet or insufficient losses to affect the spectrum at 90 GHz. The jets in Hydra A show strong steepening as they move from the nucleus suggesting unbalanced losses of the higher energy relativistic particles. The difference between these two sources may be accounted for by the lengths over which the jets are observable, 2 kpc for M87 and 45 kpc for Hydra A.



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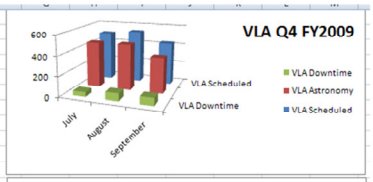
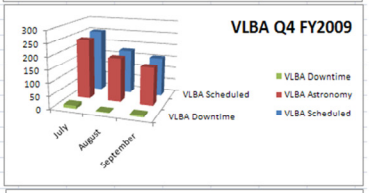
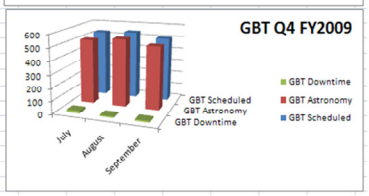
Telescope Utilization (Astronomy, Downtime, Maintenance, Test/Calibration, Unscheduled)

	Available Hours	744	744	720
		July	August	September
VLA	Scheduled	504.09	536.56	432.13
	Astronomy	*458.45*	*462.43*	*358.35*
	Downtime	*45.64*	*74.13*	*73.78*
	Maintenance	79.1	62	71.5
	Test	159.33	143.09	210.91
	Unscheduled	1.48	2.55	5.46
	Total Hours	744	744	720
		July	August	September
VLBA	Scheduled	252	177.5	156.25
	Astronomy	*239.904*	*175.37*	*149.53*
	Downtime	*12.096*	*2.13*	*6.72*
	Maintenance	71	66	123.4
	Test	104.83	144.23	108
	Unscheduled	316.17	356.27	332.35
	Total Hours	744	744	720
		July	August	September
GBT	Scheduled	529.27	541.76	504.39
	Astronomy	*508.79*	*531.3*	*492.9*
	Downtime	*20.48*	*10.46*	*11.49*
	Maintenance	164.25	148.37	171.15
	Test	50.48	53.87	44.46
	Unscheduled	0	0	0
	Total Hours	744	744	720







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There are seasonal variations throughout the year for each of the telescope/arrays.

Scheduled = planned observing time.

Astronomy = amount of observing hours that concluded

Downtime = amount of hours lost during observing

Maintenance = scheduled period for technicians to service. Observing time is not scheduled during this time. Maintenance time can/should be pre-empted in certain priority circumstances.

Unscheduled = time that went idle (unplanned); for example, for VLBA if no media was available or due to the 10 weather environments and the tiger team visits; for VLA if no dynamic project fit, for GBT = holiday.

Downtime = faults that occur during a planned observation; e.g., circuit breaker fault, fraction of array unavailable, etc.

The NRAO is determining the most effective way to tie these statistics back to the GRP estimates.

GRP Estimates:

Green Bank Telescope FY 2009 Observing Hours: 6,801

Very Large Array FY 2009 Antenna Hours: 138,000

Very Long Baseline Array FY 2009 128-Mbps Antenna Hours: 70,000

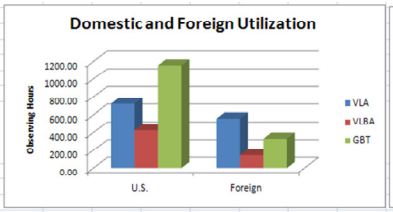
Telescope Usage by Observing Hours Expended in terms of
- US/Foreign Observers
- Astronomical Community/Graduate Students/NRAO Staff

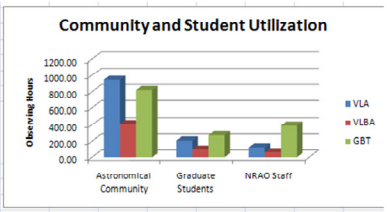
	U.S.	Foreign	Unknown
VLA	720.20	558.83	3.74
VLBA	424.98	144.77	16.00
GBT	1156.17	329.92	47.26

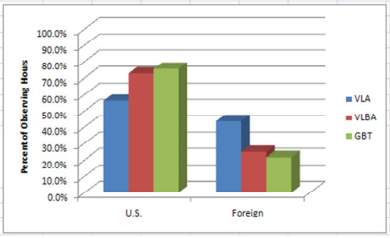
	Astronomical Community	Graduate Students	NRAO Staff
VLA	945.55	208.41	125.07
VLBA	409.35	97.37	63.04
GBT	821.72	272.29	392.08

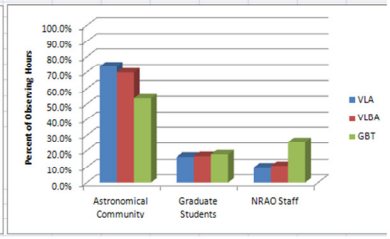
	U.S.	Foreign	Unknown
VLA	56.1%	43.6%	0.3%
VLBA	72.6%	24.7%	2.7%
GBT	75.4%	21.5%	3.1%

	Astronomical Community	Graduate Students	NRAO Staff
VLA	73.7%	16.2%	9.8%
VLBA	69.9%	16.6%	10.8%
GBT	53.6%	17.8%	25.6%









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All metrics are compiled by project team, not principle investigator. For example, if a project team consists of 5 people, and they observed for 100 hours, and 2 people were from Virginia, one was from California, and 2 were from Massachusetts, then we would report 40 hrs Virginia, 20 hrs California, 40 hrs Massachusetts.

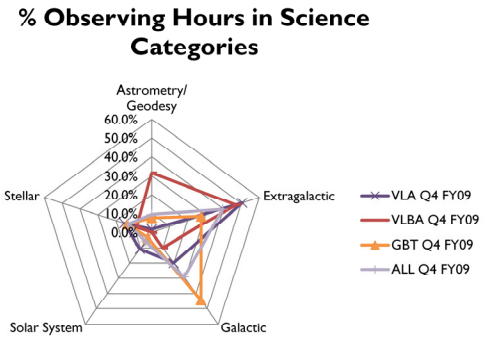
There are seasonal variations throughout the year for each of the telescope/arrays.

Top graphs are in **observing hours**.

Bottom graphs are **in % of observing hours.**

Telescope Usage by Science Category

	GBT	VLA	VLBA
SOLAR SYSTEM	3.5%	10.7%	0.0%
STELLAR	13.7%	15.3%	8.6%
GALACTIC	44.4%	19.8%	9.9%
EXTRAGALACTIC	27.6%	50.5%	47.1%
ASTROMETRY/GEODESY	7.7%	1.5%	31.7%
UNSPECIFIED	3.1%	2.2%	2.7%



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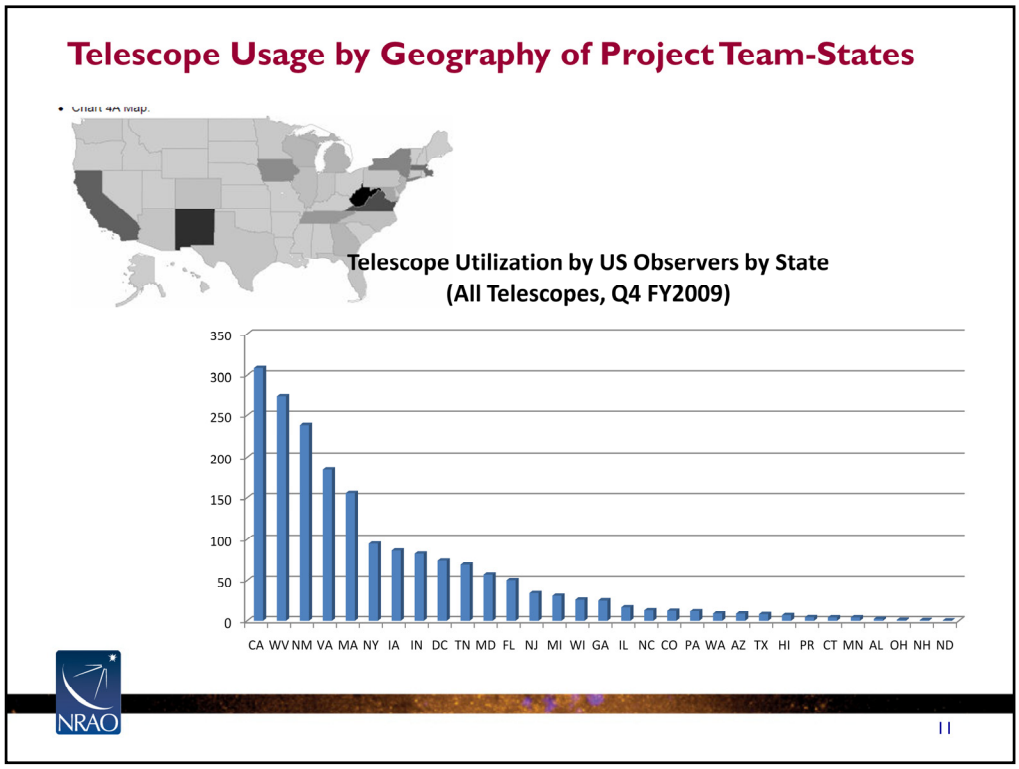
There are seasonal variations throughout the year for each of the telescope/arrays.

Basic analysis (some trending may be due to seasonal variations in activities; full year trending analysis will be performed at the culmination of the fiscal year):

•The NRAO primarily engages in galactic, or extragalactic research.

•VLA focus is predominantly in the extragalactic area, whereas the GBT is between galactic and extragalactic.

•The telescopes are used more heavily in different types of science: GBT-galactic; the VLA-extragalactic, the VLBA extragalactic, but also in a unique area of astrometry/geodesy. The VLA was also engaged this quarter in some solar system research.



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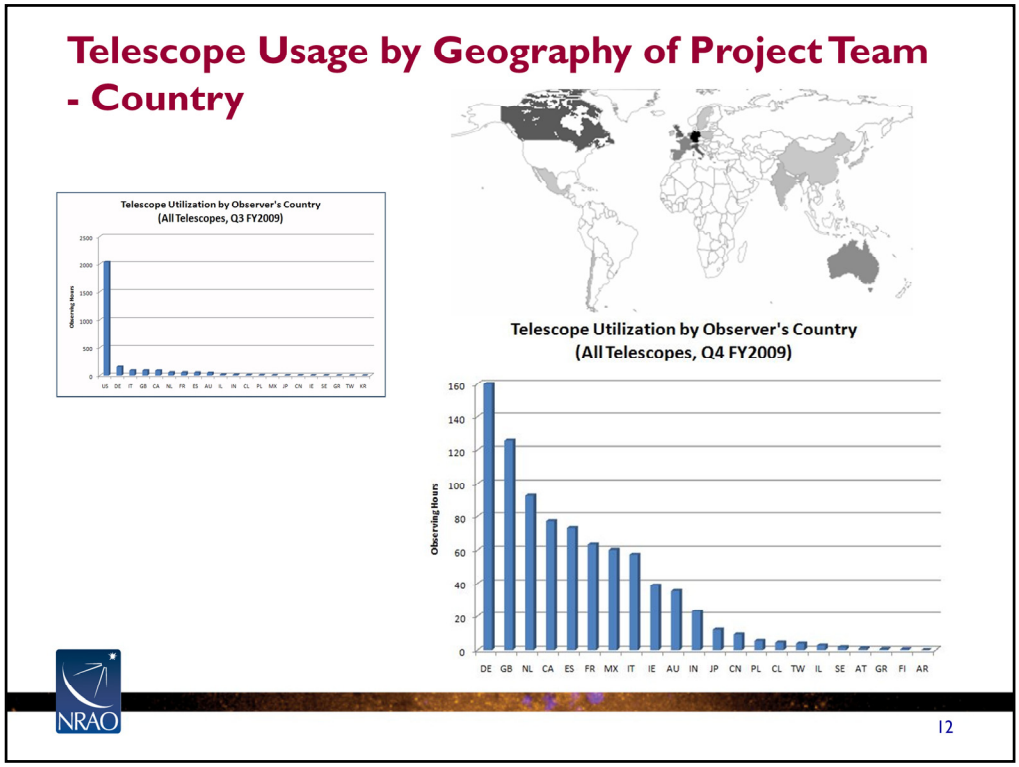
There are seasonal variations throughout the year for each of the telescope/arrays.

•**Observing hours** (by project) are used by investigators (PI) tied to US institutions, which provides the locations.

•Three of the top four are where the NRAO has facilities.



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There are seasonal variations throughout the year for each of the telescope/arrays.

Basic analysis (some trending may be due to seasonal variations in activities; full year trending analysis will be performed at the culmination of the fiscal year):

Observing hours (by project) are used by investigators (PI) tied to non-US institutions, which provides the locations.

Well represented in Germany, Italy, UK, and Canada.

AU = Australia IL = Israel
CA = Canada IN = India
CL = Chile **IT = Italy**
CN = China JP = Japan
DE = Germany KR = Korea
ES =Spain MX =Mexico
FR = France **NL = Netherlands**
GB = UK PL = Poland
GR = Greece SE = Sweden
IE = Ireland TW = Taiwan

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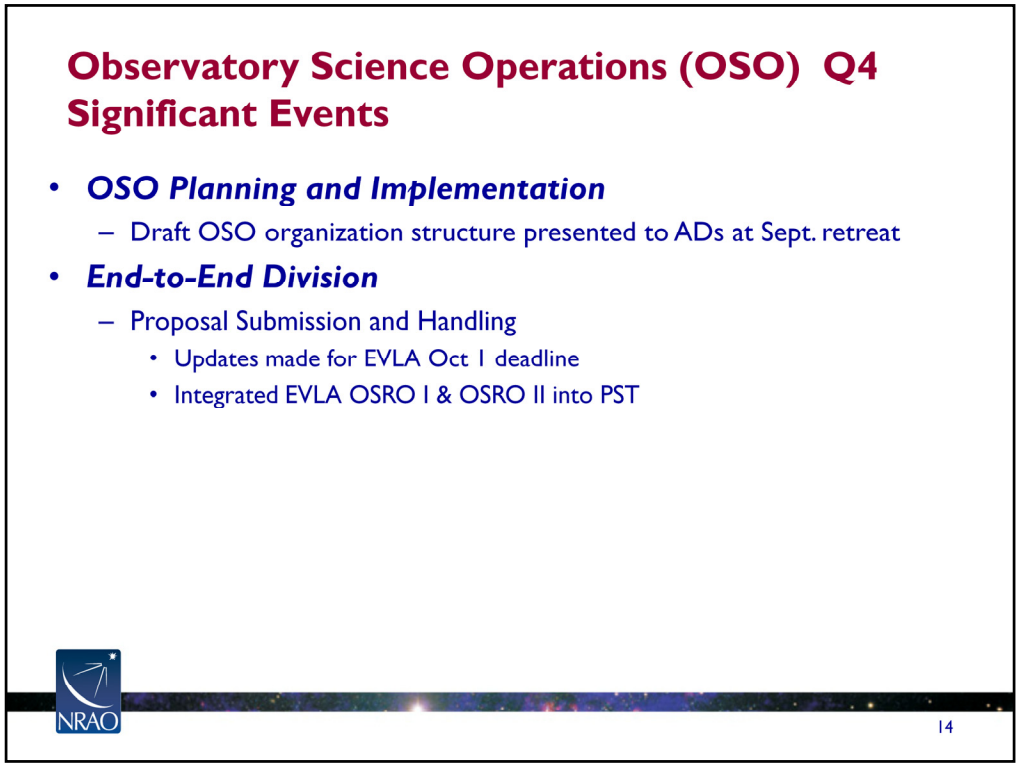
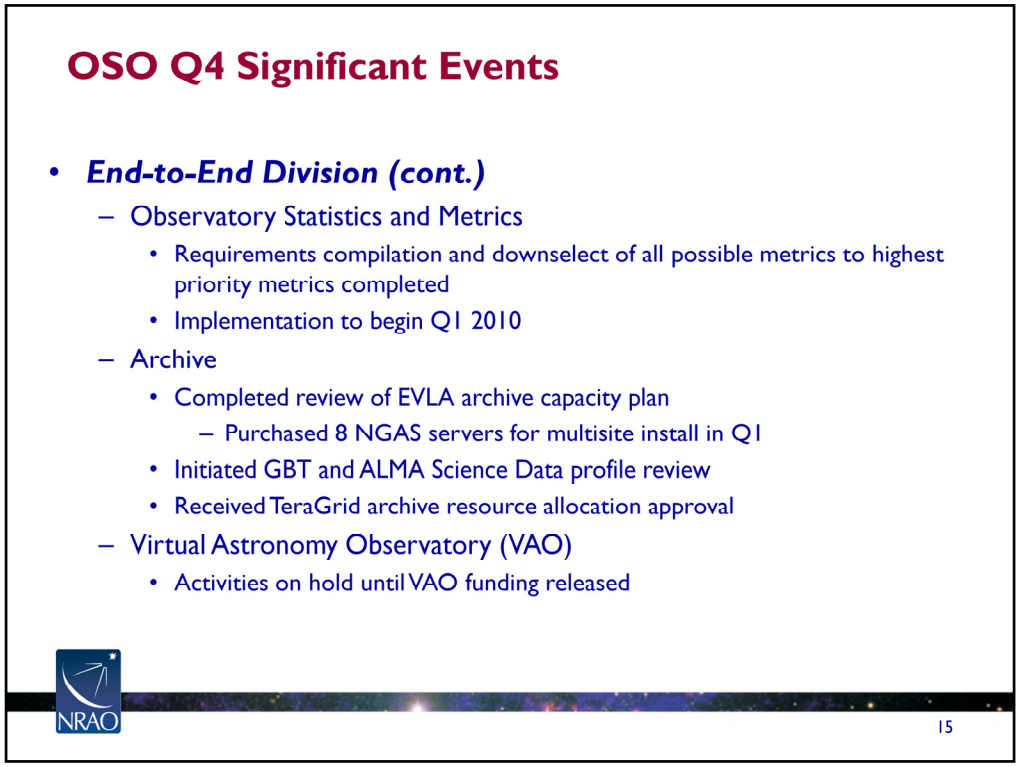


The organization structure for OSO within the overall NRAO structure was developed and discussed at the September Assistant Director's retreat meeting, resulting in an agreement on a path forward towards the development of the implementation plan.

The OSO Working Groups include: OSO Management (includes organization, WBS, staffing), User Communication & Programs (includes Science Web, Science User Outreach, User Training), User Access and Support (includes helpdesk, user portal), Observation Preparation, Proposal Process, Data Processing & Analysis (including: data processing software, pipelines, algorithms, high performance computing and networks), Archives and Virtual Astronomy Observatory (VAO), Metrics and Statistics.

Modifications to the Proposal Submission Tool for the **first call for Expanded Very Large Array (EVLA) proposals at the October 1, 2009, proposal deadline** include enabling reviewers to submit their reviews through the National Radio Astronomy Observatory (NRAO) User Portal rather than via the disparate methods currently employed for the different NRAO telescopes/sites. This new feature will be tested in-house by NRAO staff for EVLA technical reviews in FY2010 Q1.

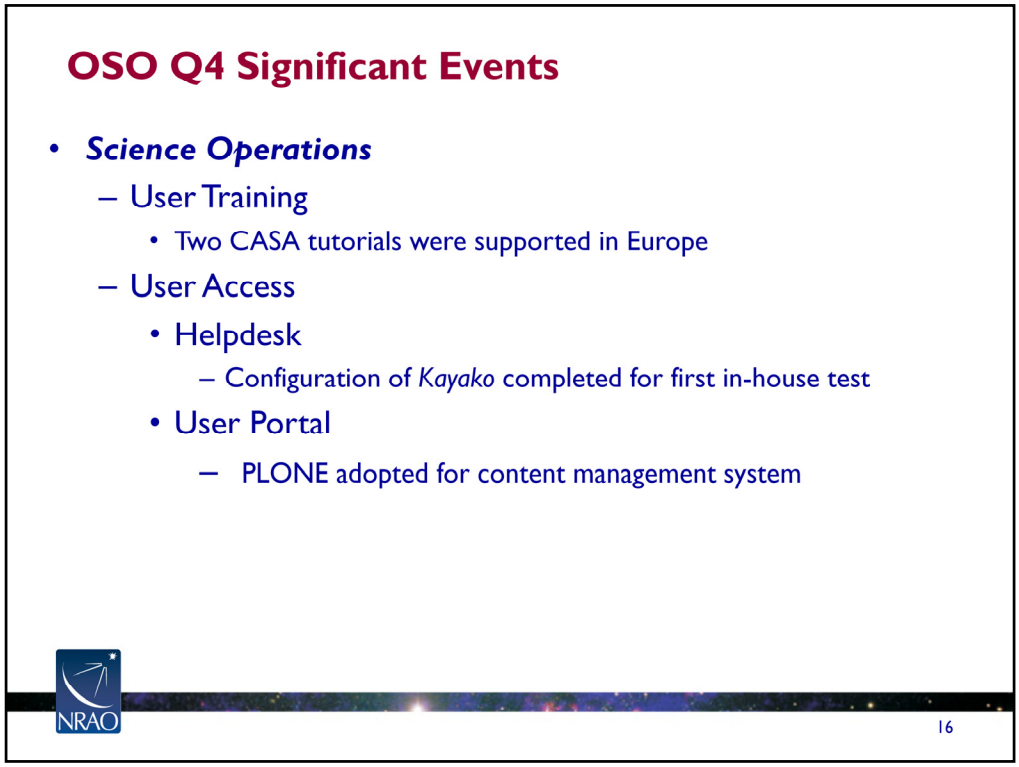


The Statistics and Metrics working group completed their survey of potential metrics to track, and **completed the down-selection to the highest priority ones** that will be routinely reported. The **implementation** of the collection of the new set of metrics will begin in FY2010Q1.

OSO Archive & VAO Working group continued to make **progress in defining the operational requirements for EVLA, GBT and ALMA** within the framework of the Archive & VAO Strategy.

A total of **8 archive servers** (80TBytes total) have been ordered and received in Socorro to initiate the migration of data from the current servers to NGAS.

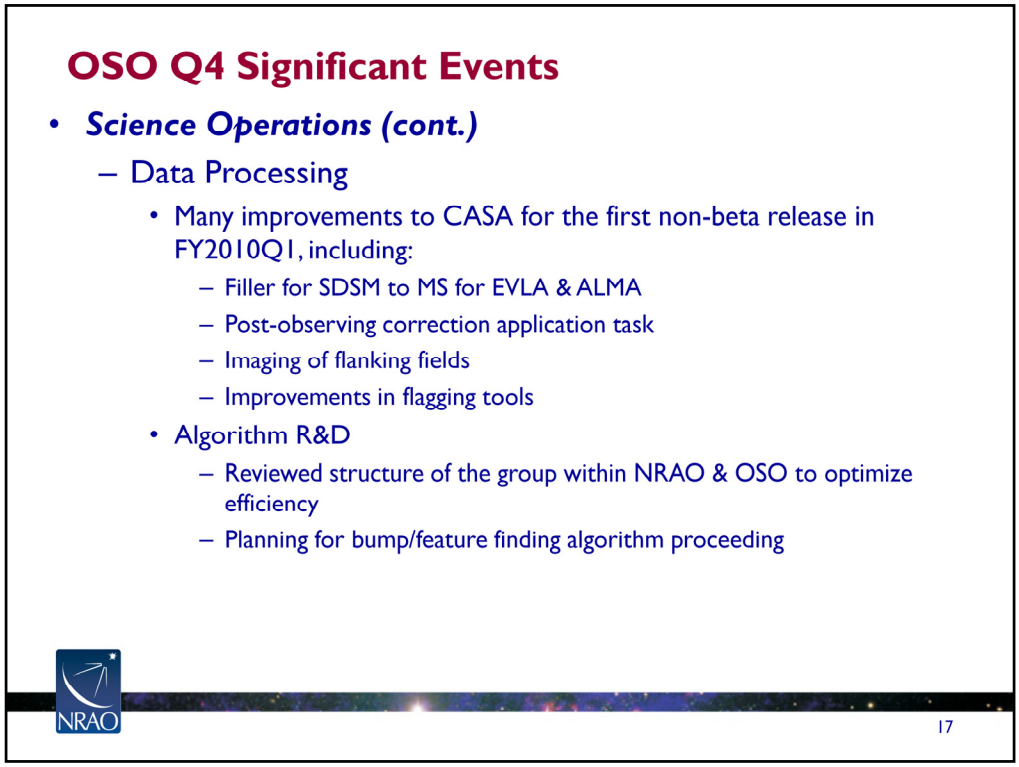
NRAO applied for, and **received a TeraGrid Resource Allocation** for compute and storage to evaluate GBT data on Sep 14, 2009.



Two **Common Astronomy Software Application (CASA) tutorials** in Europe were supported.

The ***Kayako* helpdesk was configured** in preparation for in-house testing by NRAO staff, based on interactions with other Observatories using the same kind of helpdesk. It will initially be used for dealing with tickets involving EVLA Observation Preparation, AIPS, and CASA. Testing will begin in FY2010 Q1. We have also been working on how the NRAO helpdesk will interface with the international ALMA project.

Development of the User Portal awaits hiring of an applications developer. Interviews continue for the position. **NRAO has decided to adopt PLONE** for its development environment, for synergy with the ALMA archive and other tools.



CASA software developments for **release version 3.0,** the first post-beta release, included: development of the Science Data Model to Measurement **Set filler for both ALMA and the EVLA**; improvements in the ALMA data simulator; a generic calibration value application task to provide **post-observing corrections** to applied values (like clock offsets); **imaging support for flanking fields** and imaging in non-LSRK velocity frames; improvements to the interactive **flagging/visibility plotting** GUI tool and the non-interactive flagging tool; interactive specification of regions of interest (e.g., polygons) using the Viewer GUI; investigation of support of the updated MacOS 10.6 operating installation for the release.

The best location within the OSO organization structure for the **Algorithm R&D effort** is under review. The Algorithm R&D group met with outside collaborators in Socorro on Oct 22-23 to discuss the path forward with the **bump/feature finding algorithm.**

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- Observatory Science Operations
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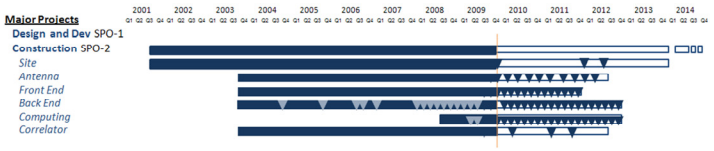
Atacama Large Millimeter/ Submillimeter Array (ALMA)

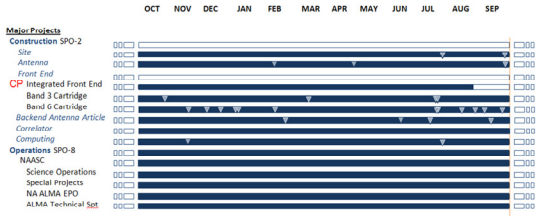
- Content provided by NRAO ALMA Project Office
- Questions on ALMA Construction addressed by Adrian Russell

ALMA Construction Project Schedule View

ATACAMA LARGE MILLIMETER/SUBMILLIMETER ARRAY (ALMA)
PROJECT/PROGRAM OVERVIEW



ATACAMA LARGE MILLIMETER/SUBMILLIMETER ARRAY (ALMA)
Program Plan



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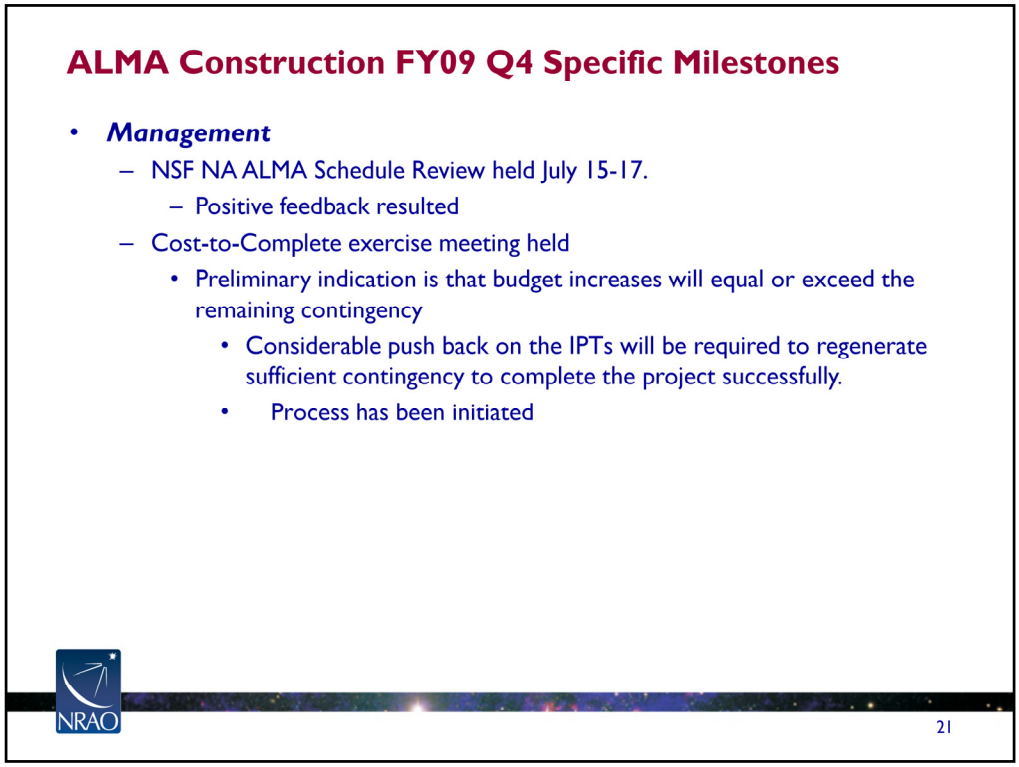
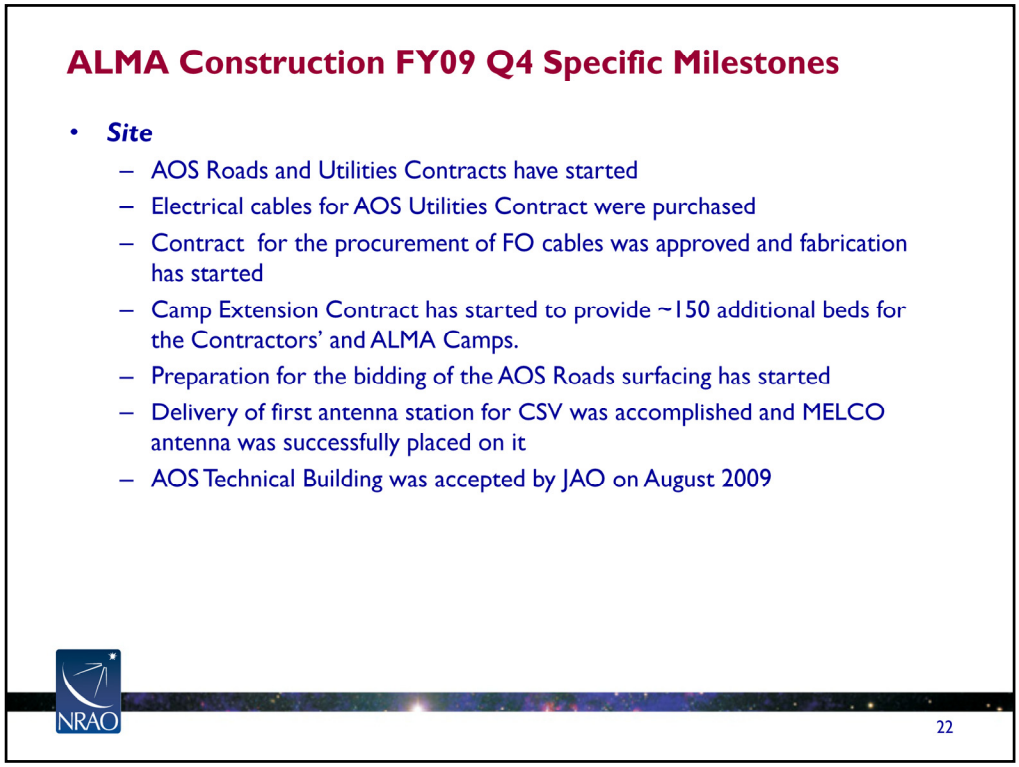
The first graph illustrates the full lifecycle. The second graph is this fiscal year view. The vertical line represents where we are today. The CP represents the critical path.



The National Science Foundation (NSF) North American (NA) Atacama Large Millimeter/ Submillimeter Array (ALMA) **Schedule Review** was held in Charlottesville, VA, July 15-17. It concluded that "The ALMA NA management team is highly capable and taking the appropriate steps to complete their work scope within the approved total project cost…". The final review document is available at: *http://staff.nrao.edu/wiki/pub/ALMA/NSFReview2009-07-15/ALMA_Report0721Changed.pdf*.

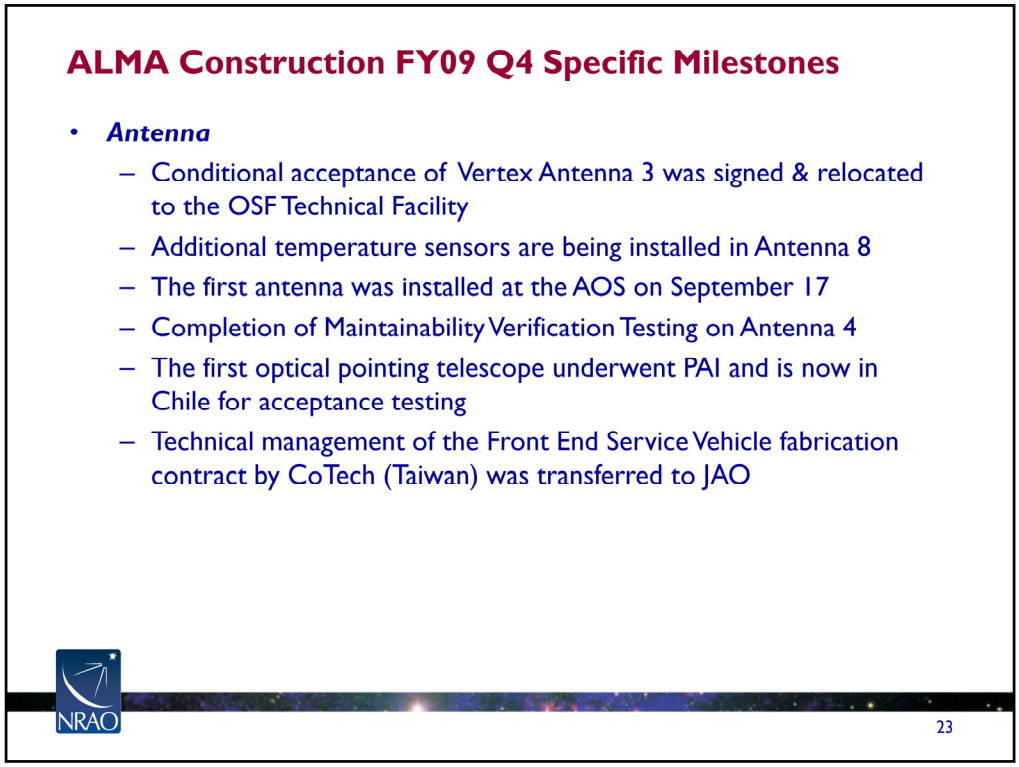
The first pass of the **cost to complete exercise** will be held in Q1 2010 (October 21-24), at the Management Integrated Product Team (IPT) Meeting in Charlottesville, VA. NOTE: at the time of this briefing has occured with the following results: preliminary indication is that budget increases will approximately **equal or exceed the remaining contingency**. A wide range push back process has been initiated based on targets set at the Management IPT (MIPT). It is clear that considerable push back will be required in order to **regenerate sufficient contingency** to complete the project successfully.



The **AOS Roads and Utilities Contracts** were approved by the NSF, awarded and the work is already under way. These contracts will install the power and fiber optic lines to all antenna stations at the AOS. The electrical cables for the AOS Utilities contract were purchased in the US (Okonite of Lexington, Kentucky). The contract for the **procurement of FO cables** was approved and fabrication of the cables has started. These will be delivered in Q1 of FY2010, on time for the first milestone in the Utilities Contract (Dec 2009). Delivery of electrical transformers and switchgears for the AOS Utilities contract has started, to be completed on schedule.

The **Camps Extension Contract** has been approved and work has started on site to deliver the ~150 new beds in Q1 FY2010. Bedrooms and full furnishing for workers, supervisors and some ALMA personnel is ongoing. Delivery is expected in stages according to the present needs. The bidding for the **AOS Roads Surfacing** is being prepared.

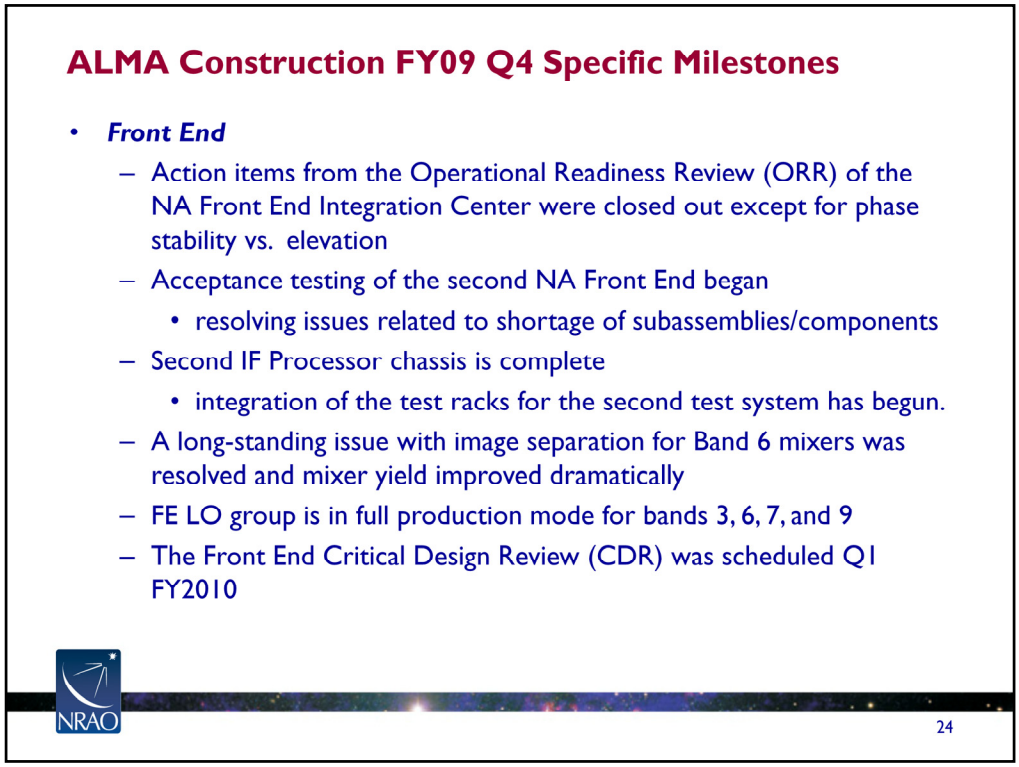
The **first antenna station**, pad A106 (close to the AOS Technical Building), was finished and the **first antenna transported to the AOS was installed** on it on September 17th. The **AOS Technical building acceptance** has been granted in August 2009, only the JAO's final signature of acceptance is pending.



On September 29 the **third Vertex antenna** was conditionally accepted and was **relocated to the OSF Technical Facility**.

As stated last quarter, NRAO and Vertex agreed that antenna 8 will be outfitted with the **additional temperature sensors** desired for further investigations of the surface accuracy vs. temperature performance. Because of the success with holography experiments on antenna 3 and the excellent analysis and modeling performed, it is not expected that a special holography campaign will have to be performed on antenna 8.

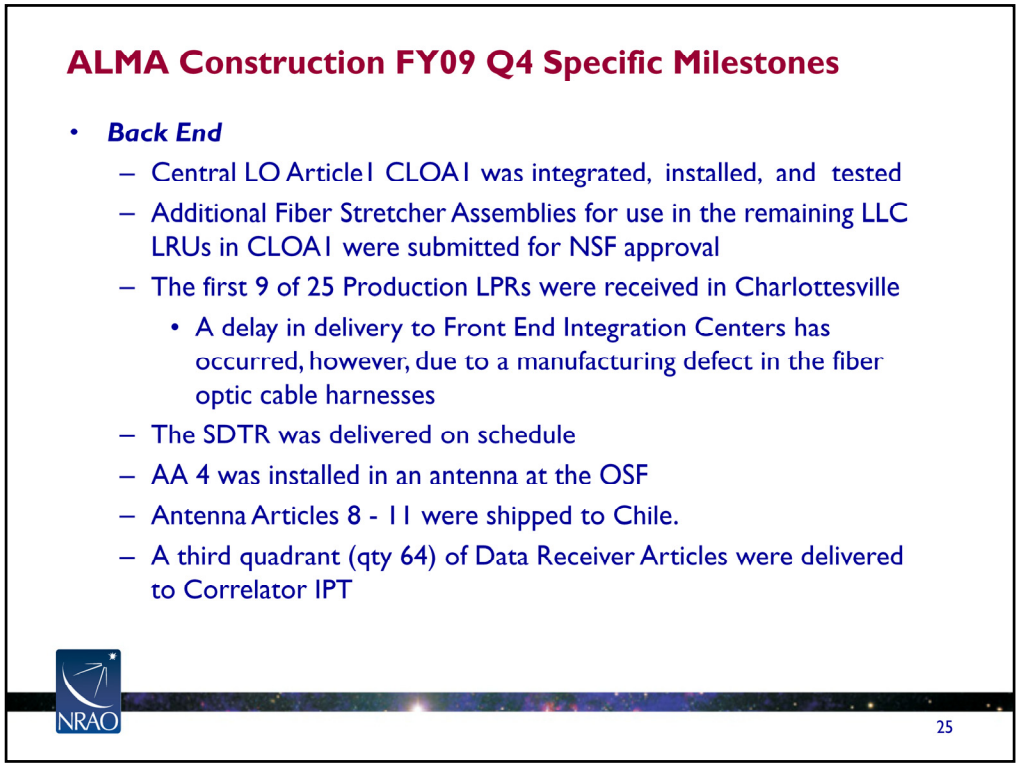
ALMA succeeded in placing the **first antenna at the AOS** on September 17, which is the first step towards achieving phase closure before the end of the calendar year. The **Maintainability Verification Testing** on antenna 4 was completed in August. The outcomes were primarily required revisions to the maintenance procedures and are being closed out by Vertex. It is expected this will be fully complete by November 2009. The first **optical pointing telescope underwent Preliminary Acceptance In-House (PAI)** in Tucson and is now in Chile for acceptance testing. Technical management of the **Front End Service Vehicle fabrication contract** by CoTech (Taiwan) was transferred to the JAO. Administrative management continues by NRAO.



The **Operational Readiness Review (ORR)** for the NA Front End Integration Center (FEIC) resulted in 11 action items that needed to be closed. **Acceptance testing for the second NA FE** began, and beam scans for all 4 bands were completed. The Project Management Control System (PMCS) team and the Regional Project Managers and IPTs are working to resolve issues related to the shortage of subassemblies/components to be delivered to FEICs. **Assembly and upgrade of the FEIC's second IF Processor chassis** is complete, and integration of the test racks for the second test system has begun. When completed early in 2010, this will significantly increase the throughput of the NA FEIC and provide backup in case of equipment problems.

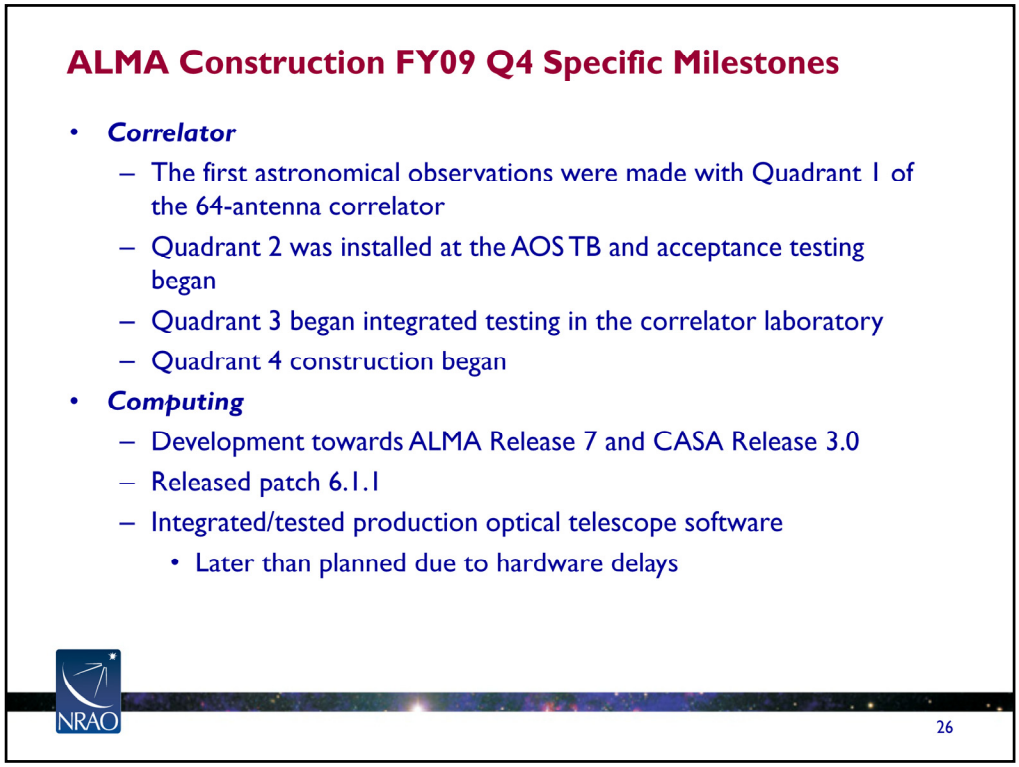
A **major breakthrough in Band 6 mixer yield occurred** with the determination that the production batch of commercial IF hybrids were of a modified design which did not work properly at cryogenic temperatures, and this was causing nearly half of the tested mixers to be rejected for poor image separation. A new design IF hybrid which works properly when cooled has greatly increased acceptance, so that the rate of mixer production appears to be no longer an issue.

The FE LO group is now considered to be in **full production mode for bands 3, 6, 7, and 9**, nearly in production for Band 4, and still developmental for Bands 8 and 10. The **Front End Critical Design Review (CDR) was scheduled** for the next quarter, and preparation of documentation including that for remaining sub-assembly CDRs commenced.



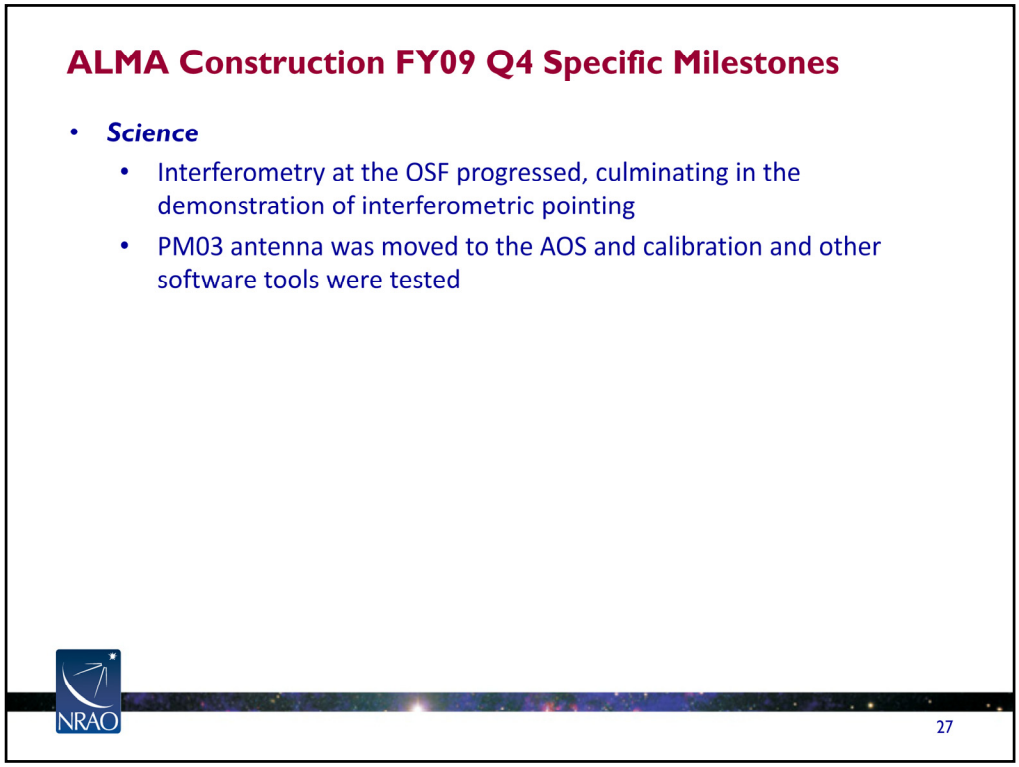
Central Local Oscillator (LO) Article1 (CLOA1) was shipped from North America in late June 2009. Reintegration and installation occurred in July and early August, and acceptance testing was successfully carried out by the NRAO staff in August and September. Additional **Fiber Stretcher Assemblies** for use in the remaining Line Length Correctors (LLC) Line Replaceable Units (LRU) in CLOA1 were submitted for NSF approval.

The first 9 of 25 Production **LO Photonic Receivers** (LPRs) were received in Charlottesville. **LO Photonic Articles** began to arrive from the integration vendor and are undergoing testing, and a successful Manufacturing Readiness Review (MRR) is anticipated in early October at which point Articles 11 through 25 will begin integration. A delay in delivery to Front End Integration Centers has occurred, however, due to a manufacturing defect in the fiber optic cable harnesses. Antenna Articles continue to be integrated and shipped on schedule from Socorro. In addition to this work in North America, staff have been travelling to Chile to aid AIV in acceptance testing and installation. Future acceptance and installation is expected to be wholly performed by AIV staff. The **Single Dish Timing Rack (SDTR)**, an additional Central LO source for the antenna testing at OSF, was delivered on schedule. **Antenna Article (AA) 4 was installed** in an antenna at the OSF. Antenna Articles 8-11 were shipped to Chile. AAs 12-15 were completed in anticipation of shipment. A **third quadrant's worth of Data Receiver (DRX) Articles** were delivered to the Correlator IPT for use at the AOS. One quadrant, 64 articles, remains to be delivered by Back End, currently estimated for Q2 FY2010 . Additional DRX circuit boards are being procured to meet the final quadrant's needs but require NSF approval prior to any contract award.



Detailed checkout of the 67 defined modes for **correlator** operation continued, using artificially generated test signals. Approximately 35% of the modes have been thoroughly verified, including the signal-to-noise ratio improvement from 4-bit and oversampling. The **first astronomical observations** were made with Quadrant 1 of the 64-antenna correlator. **Quadrant 2 was installed at the AOS TB** and acceptance testing began. **Quadrant 3** began integrated testing in the correlator laboratory in Charlottesville, VA. The construction of **Quadrant 4** started.

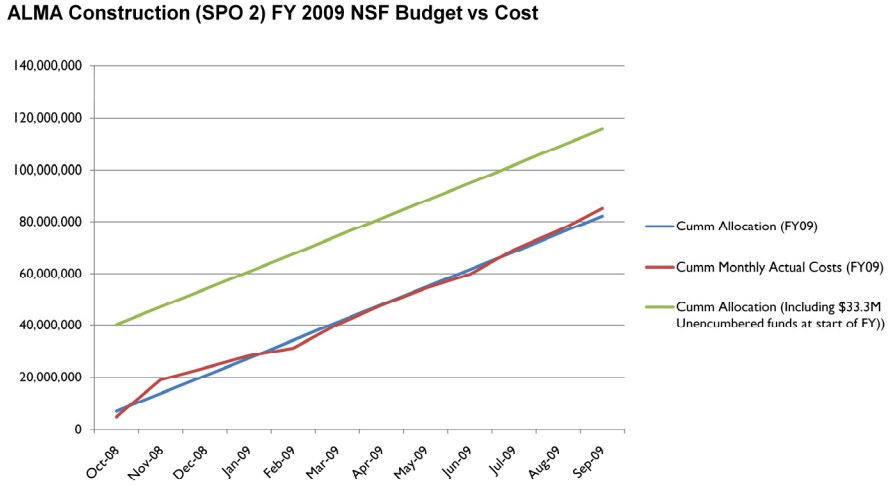
In Computing, most of the effort this quarter went towards the development of the **next releases of both CASA (R. 3.0) and the ALMA (R. 7)** software. We **released patch 6.1.1**, which had support for the AOS Central LO. The **production optical telescope software was tested successfully** in Chile, although later than planned due to hardware delays.



The Science IPT has continued to scientifically test the calibration and interferometric software tools implemented by the Computing IPT on the production ALMA system during initial Commissioning at the Array Operations Site. **Interferometry at the OSF** progressed, culminating in the demonstration of interferometric pointing.

PM03 antenna was moved to the AOS and calibration and other software tools were tested. Pointing and refined holography established that Vertex antennas meet pointing and surface accuracy specifications over an extrapolated range of temperatures. A review of Commissioning and Science Verification plans was held September 2-3. ANASAC met in Charlottesville to discuss ALMA development and other topics.

Financial Information



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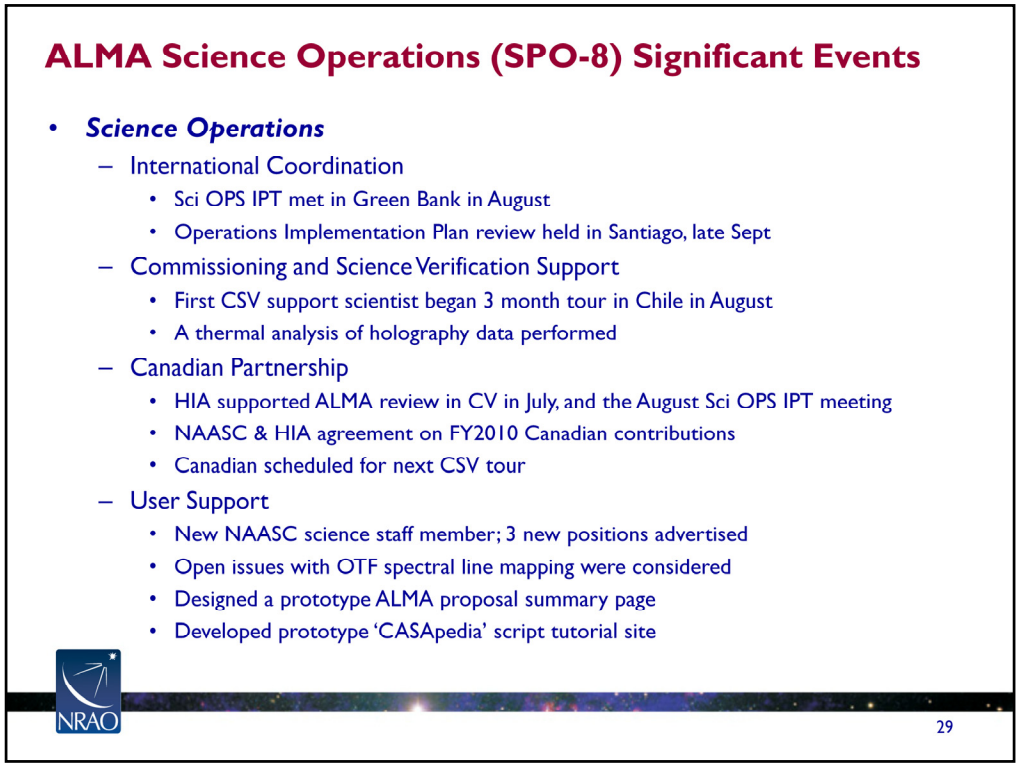
All detailed information on the financial or milestones performance for SPO 2 ALMA Construction will be provided by Adrian Russell and/or the NRAO ALMA Project Office.

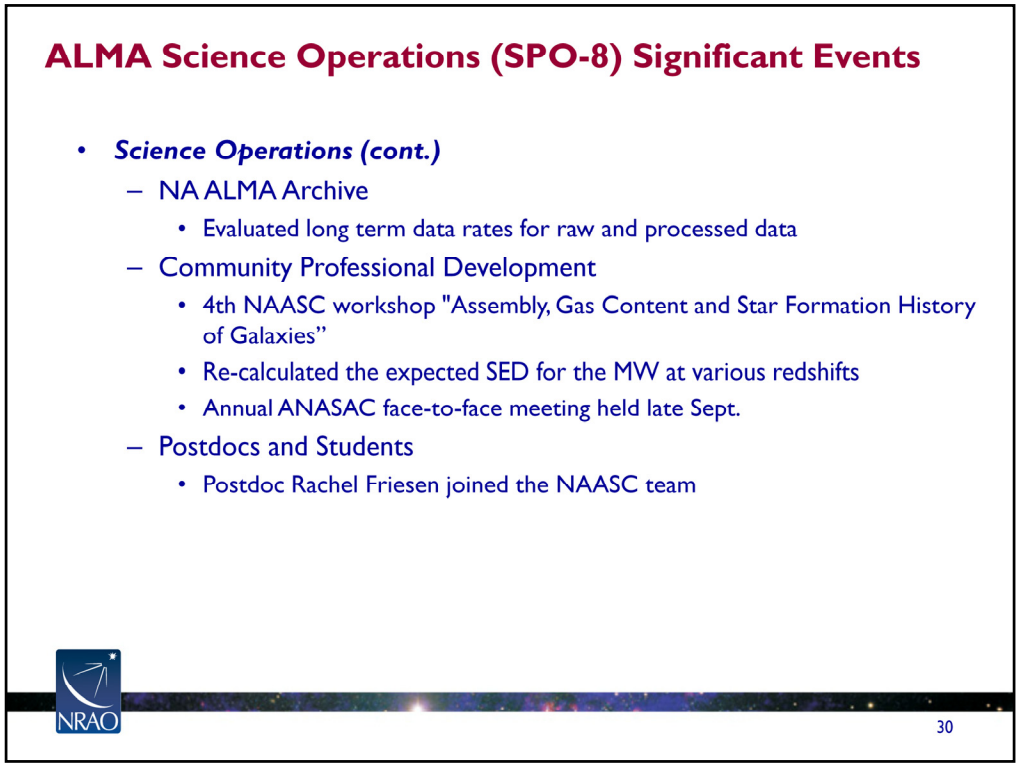


In preparation for Science Operations Implementation Plan review the **Sci OPS IPT met in Green Bank in August.** The NAASC Implementation Plan, the DSO & ARC Coordinated Activities Plan were written, and contributions made to all other documents, including the ALMA Project Plan. **Presentations given at the review, Sept 28-30 in Santiago** on ALMA from Users Perspective, ALMA Science Operations Software, and the NAASC. Work began on the revision to the ALMA Operations Plan.

The first NAASC Commissioning and Science Verification (CSV) liaison scientist began duties in Chile including shifts at the OSF. A **thermal analysis of holography** data for the characterization of the surface of the Vertex antennas was performed.

An agreement with Herzberg Institute of Astrophysics (HIA) on the **Canadian proposed "in-kind" contribution for CY2010** was made. **A Canadian will take the next CSV tour to Chile,** starting in early December. The **NAASC's second CSV liaison scientist, Kartik Sheth**, joined us in September. His first 3 month tour to Chile will begin in January. **Three new scientist positions have been advertised**.

Produced summary of considerations & **open issues regarding spectral line OTF mapping** with ALMA & distributed to working group. A **prototype summary page for ALMA proposal submission** was developed. A NAASC sabbatical visitor **has prototyped a web site based on mediapedia** (which is used by Wikipedia)**, to support demonstrations of the use of validated CASA scripts.**



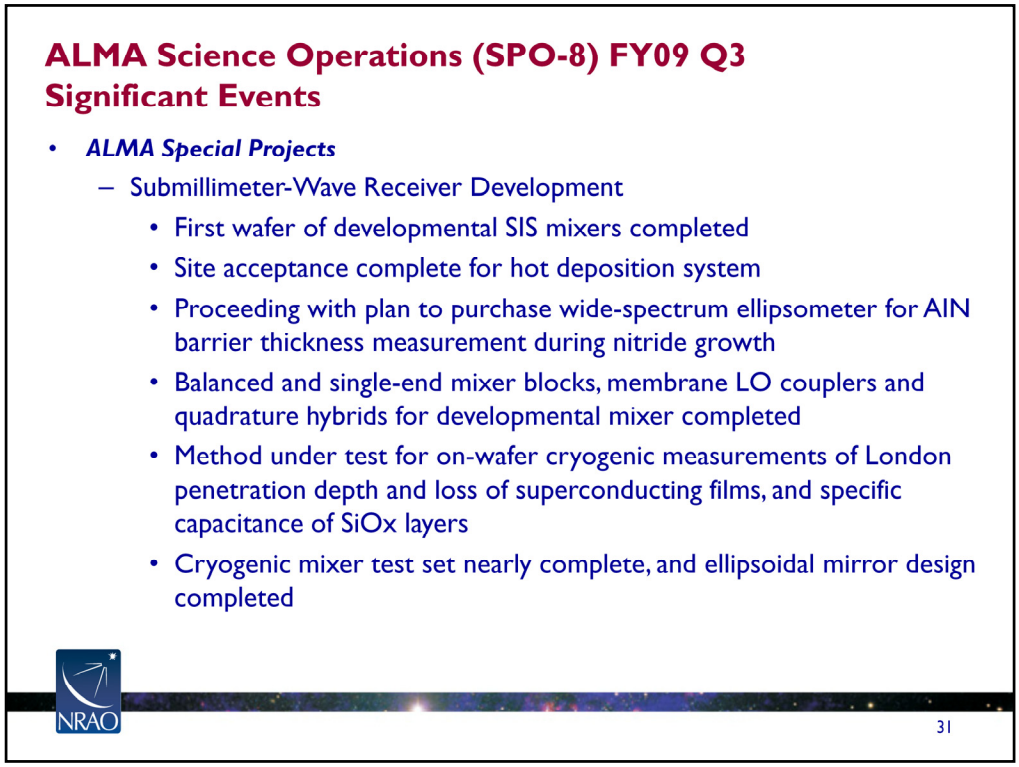
The ALMA archive and data rate requirements on planned NRAO Data Center in Charlottesville were evaluated.

The 4th NAASC workshop "Assembly, Gas Content and Star Formation History of Galaxies" was held Sep 21-24. There were 170+ participants, including more than 60 students and postdocs.

Re-calculated the expected **SED for the MW at various redshifts** with the 24 hour ALMA sensitivities for Early Science and full array.

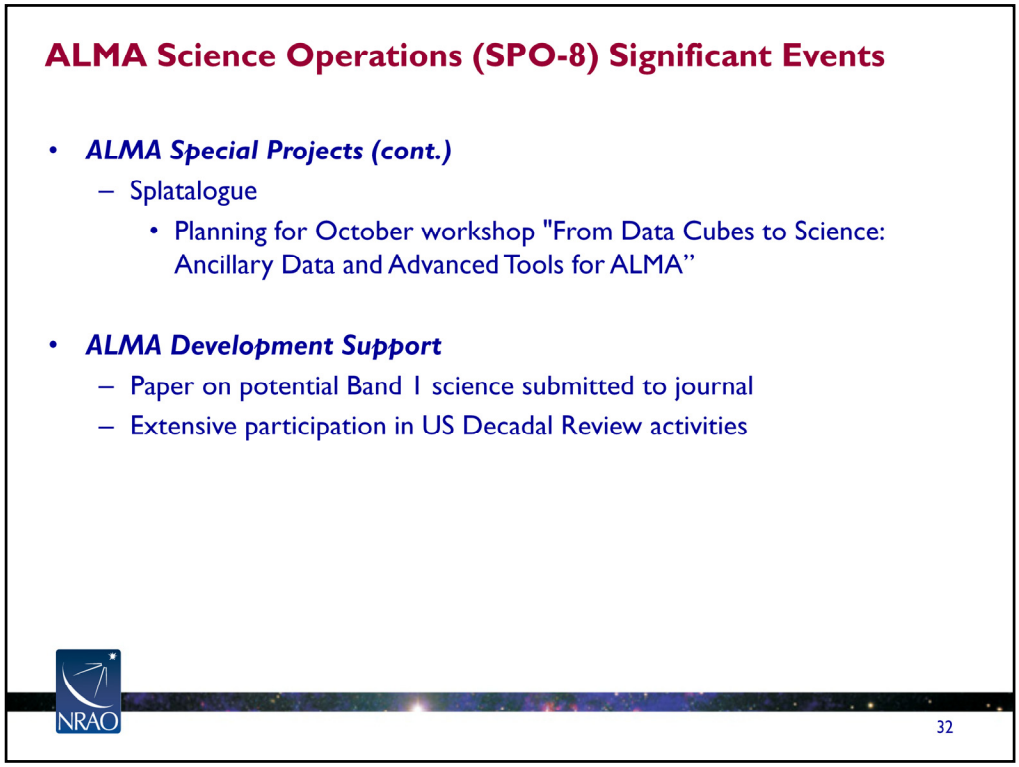
Prepared for & held **ANASAC f2f meeting Sept 25**, include background material for ASAC charges on ARC preparedness, ALMA development program, ALMA proposal review process.

NAASC CASA **post-doc Rachel Friesen** started. She will work on scientific use of CASA especially for heterogeneous imaging.



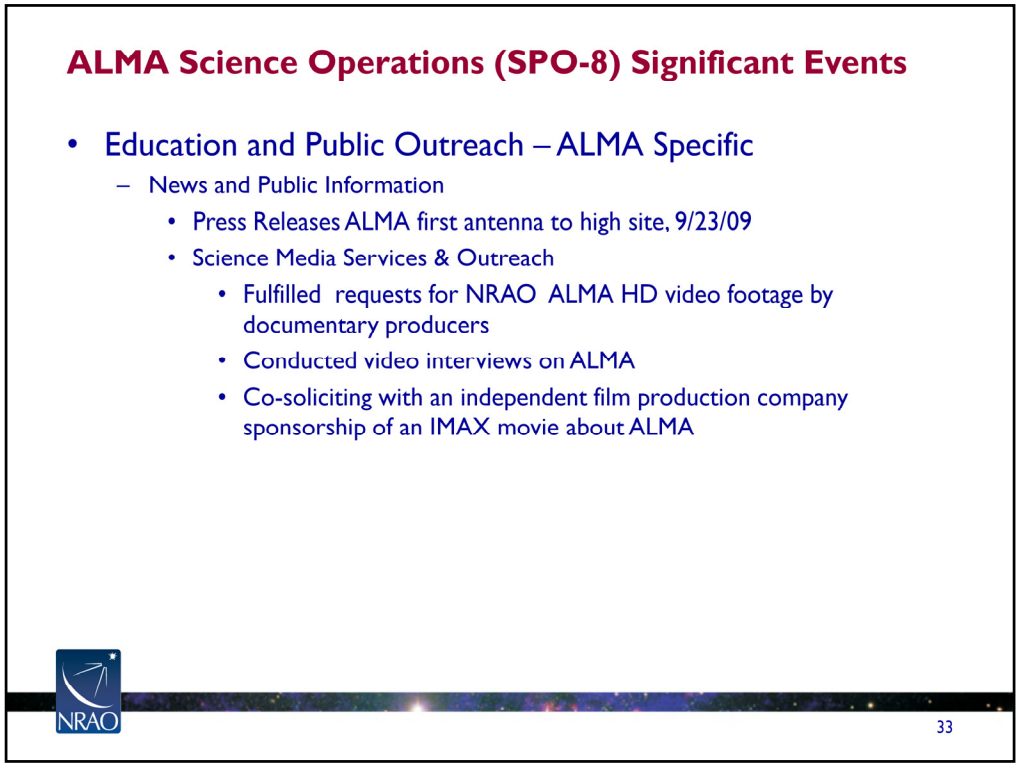
Work continues towards a 350-μm SIS mixer. At the University of Virginia Microfabrication Laboratory (UVML), high quality AlN SIS junctions with very high critical current density were demonstrated in the last year. Key to a highly stable production process is accurate determination of the thickness of the AlN barrier during deposition, accomplished by ellipsometry. **Discussions are under way with an ellipsometer manufacturer to obtain a wide-spectrum instrument** to replace the current monochromatic one whose accuracy is marginal for this work. Also at UVML, work continues on the fabrication of high quality NbTiN for use above ~700 GHz. The Hot deposition system ordered 12/2008 is almost ready for delivery. **Site acceptance is complete** and the system should be delivered in December. Also essential to the NbTiN development is the ability to measure the properties of the superconducting films at 4 K. **A method is being developed for measuring test circuits using a cryogenic wafer prober.** This will allow on-wafer measurements of the specific capacitance of the SiO_x layers, and the penetration depth and loss of the superconductors, which are difficult to measure after the devices are detached from their parent wafer.

While UVML develops the new materials and fabrication processes, the CDL is prototyping the 350-um mixer at half the frequency (440 GHz) to optimize a new mixer design using silicon membranes and gold beam leads. **The first wafer of 500 GHz SIS mixers has been completed** at UVML and is awaiting initial DC measurements. **Balanced and single-ended mixer blocks have been fabricated at the CDL. Membrane LO couplers and quadrature hybrids** for these mixers have been fabricated and satisfactorily tested. The **cryogenic test system for SIS mixers at 440 GHz is nearly complete.** This includes the DC bias and IF components, optics, and LO and signal sources. An ellipsoidal mirror design is complete and has been sent to our collaborators at the Arizona Radio Observatory for fabrication.



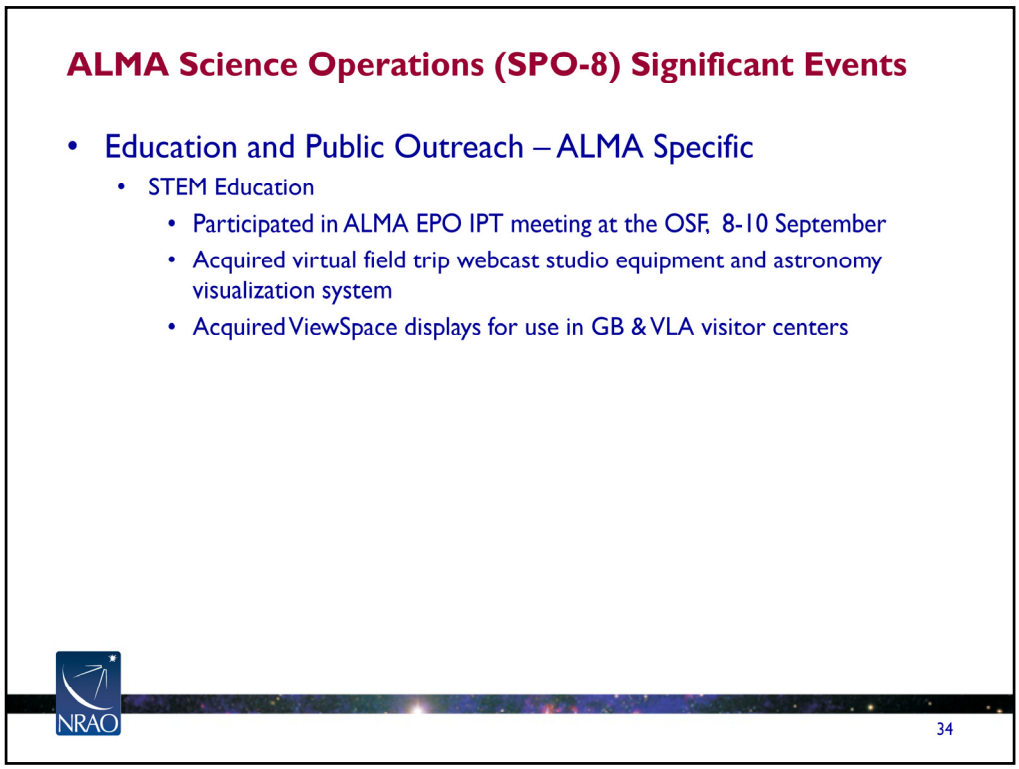
Updates and maintenance continue for Splatalogue. An **international technical workshop has been planned** for October in Cologne, Germany, to work towards consensus on line database support for the community, in support of ALMA proposals and data analysis. Requirements for a subset of the database for use in offline tools (the OT and CASA) is sought at the workshop.

Colleagues from the Hertzburg Institute, Canada, have prepared a journal **paper on the science case for the development of ALMA Band 1. Involvement with the processes of the Astronomy Decade Review** have continued, with responses to calls for information.

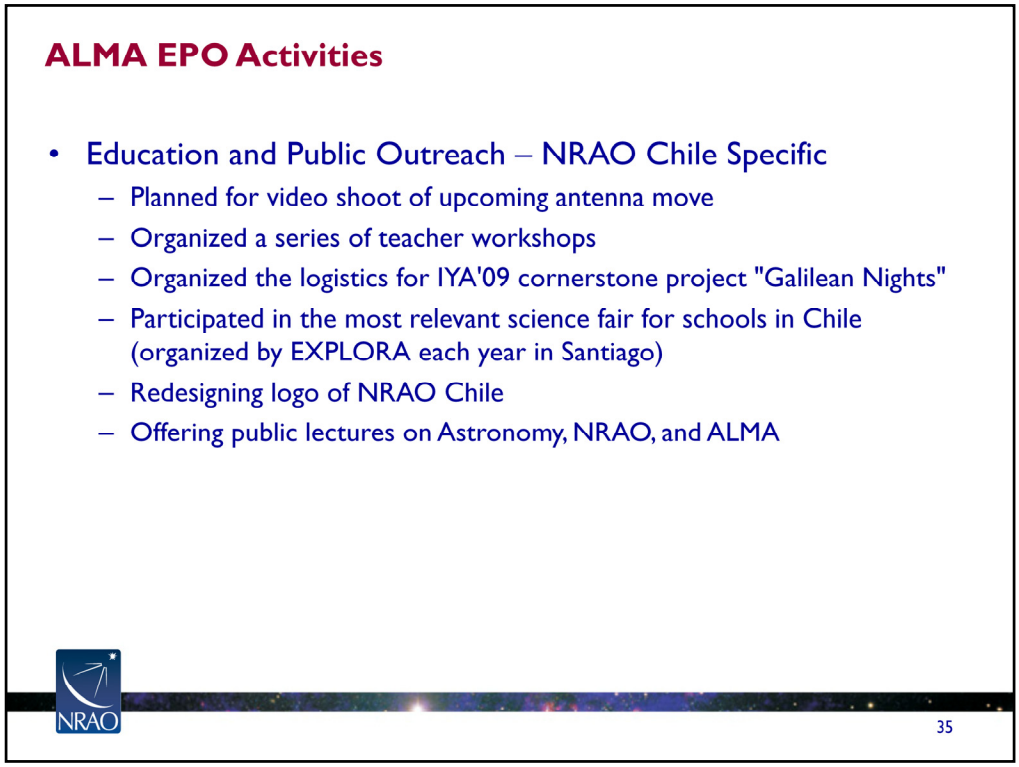


Published **press release for the first antenna** to the ALMA high site on 9/23/09.

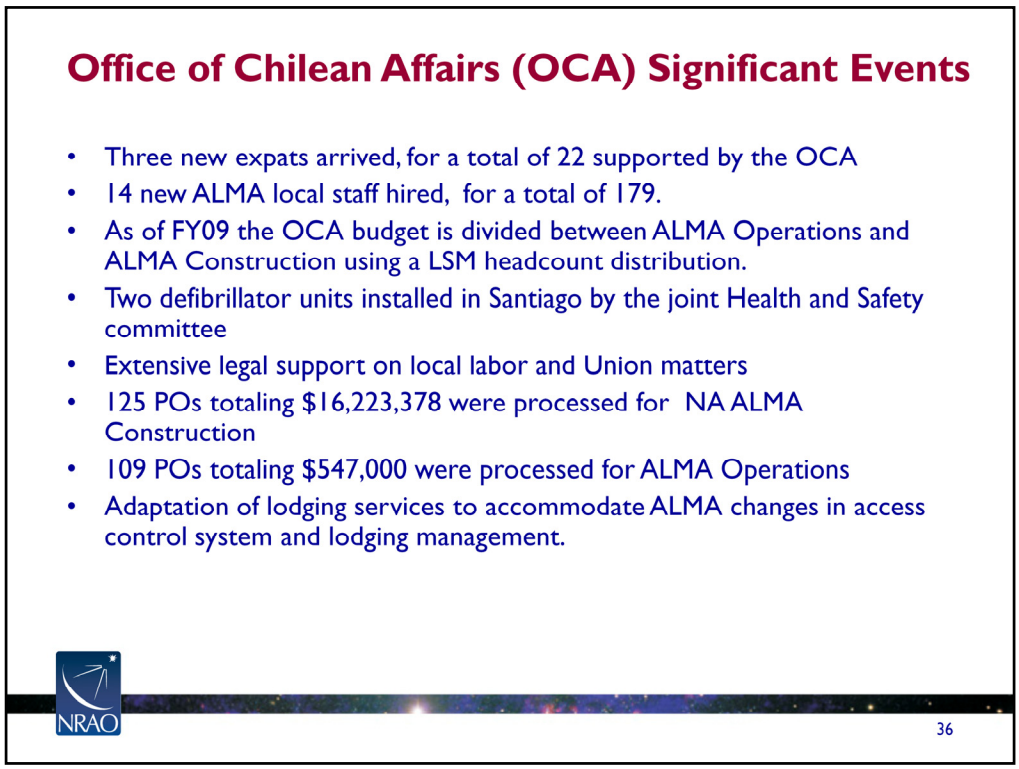
In the areas of Science Media Services and Outreach, fulfilled requests for NRAO ALMA HD video footage by documentary producers, **conducted video interviews** in collaboration with outside video producers, edited video "pitch reel" for use in negotiating a commission for a science documentary about ALMA, and met with AUI to discuss logistics on co-soliciting with an **independent film production company sponsorship of an IMAX movie about ALMA.**



In the area of Science, Technology, Engineering, and Mathematics (STEM) education, participated in **ALMA EPO IPT meeting** at the OSF, 8-10 September. ALMA booklets now part of Williams College astronomy curriculum (Jay Pasachoff). Acquired **virtual field trip webcast studio equipment** and astronomy visualization system. In addition, **ViewSpace displays** were acquired for use in GB & VLA visitor centers.



This quarter, EPO participated in several activities in support of NRAO Chile. **Planned for video shoot** of upcoming antenna move. Organized a series of **workshops to train teachers** on how to use software to support the teach of Astronomy in classes. Organized the logistics (institutions participating, program of activities and attendance of public) for **IYA'09 cornerstone project "Galilean Nights".** Participated in the most relevant science fair for schools in Chile (organized by **EXPLORA** each year in Santiago). Also, participating in regional version of this fair in Valdivia (and sponsoring the awards). **Redesigning logo of NRAO Chile**, and supervising its change in internal issues. Offering **public lectures** on Astronomy, NRAO, and ALMA.



OCA continues its support and management of NA Expatriates working in Chile. **Three new Expatriates were accredited** bringing the total number to 22. OCA has reviewed and signed a total of **14 new ALMA Local Staff contracts** on behalf of the NA Executive, designated as the sole employer of Local staff for ALMA in Chile. This brings the total number of employees for which OCA provides ALMA with legal, payroll and travel support to **179 local staff**. As of FY09 the **OCA budget is divided between ALMA Operations and ALMA Construction**. A LSM **headcount distribution will used**. The headcount distribution for FY09 resulted in 47.5% to Construction and 52.5% to Operations.

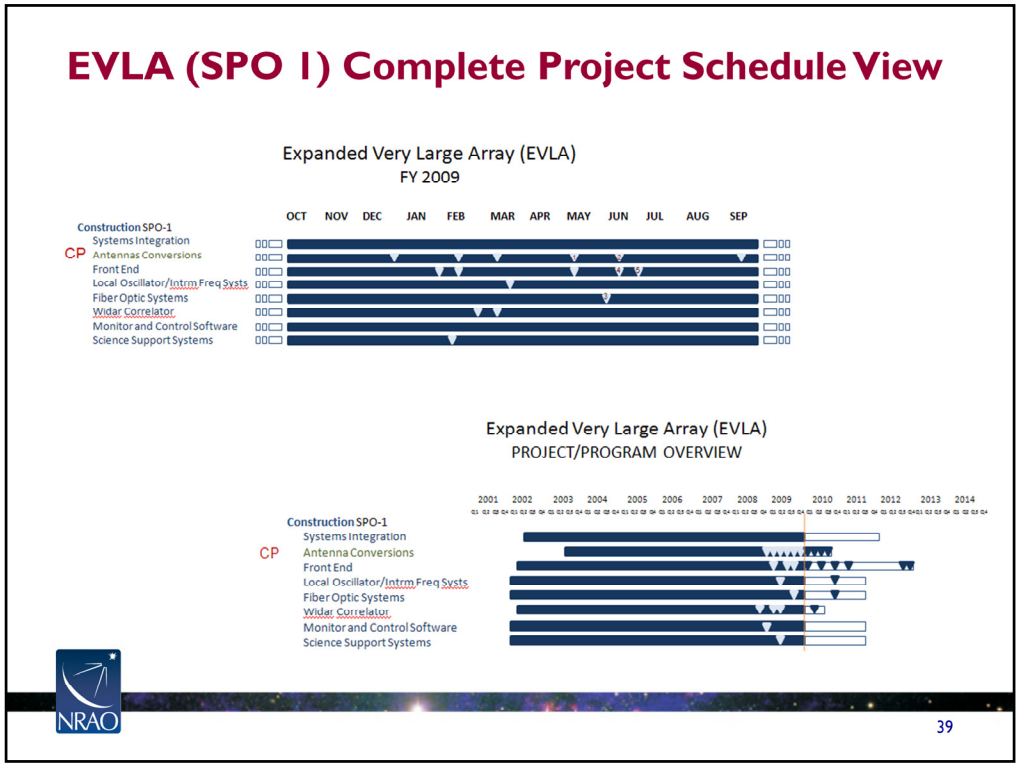
Two defibrillator units were installed in the Santiago offices as requested by the Joint Health and Safety committee managed by the OCA. OCA has also provided extensive legal support to the NA Executive on Chilean **labor-related matters**, especially now on Union matters. OCA continues the management of the joint health and safety Committee and transmits its suggestions to the ALMA administration. OCA has provided the legal and institutional support for contracts and procurements for ALMA as follows: a total of **125 purchase orders were made for ALMA Construction ($16,223,378)** and **109 for ALMA Operations ($547,000)**. The activities for ALMA Construction involve those described in the Site IPT section, namely AOS Roads Construction Contract, AOS Utilities – Electrical and FO cables installation contract, Fiber Optic Cable supply and Contractors' Camp expansion. Related to the Sodexho contract (Catering, Cleaning and Maintenance), **improvements were introduced in the catering services** provided at the Contractors camp and **changes were introduced in lodging services** in order to accommodate the ALMA new access control system and lodging management. Monthly reports were issued to Conama (environmental authority), related to flora/fauna and archaeological follow-ups. OCA personnel participated in the Environmental analysis related to the temporary power supply system that will remain as backup during Operations.

Agenda

- Science Results/Metrics
- Observatory Science Operations
- Site Specific Activities
  - ALMA
  - VLA/EVLA
  - GBT
  - VLBA
- Observatory-wide Operations

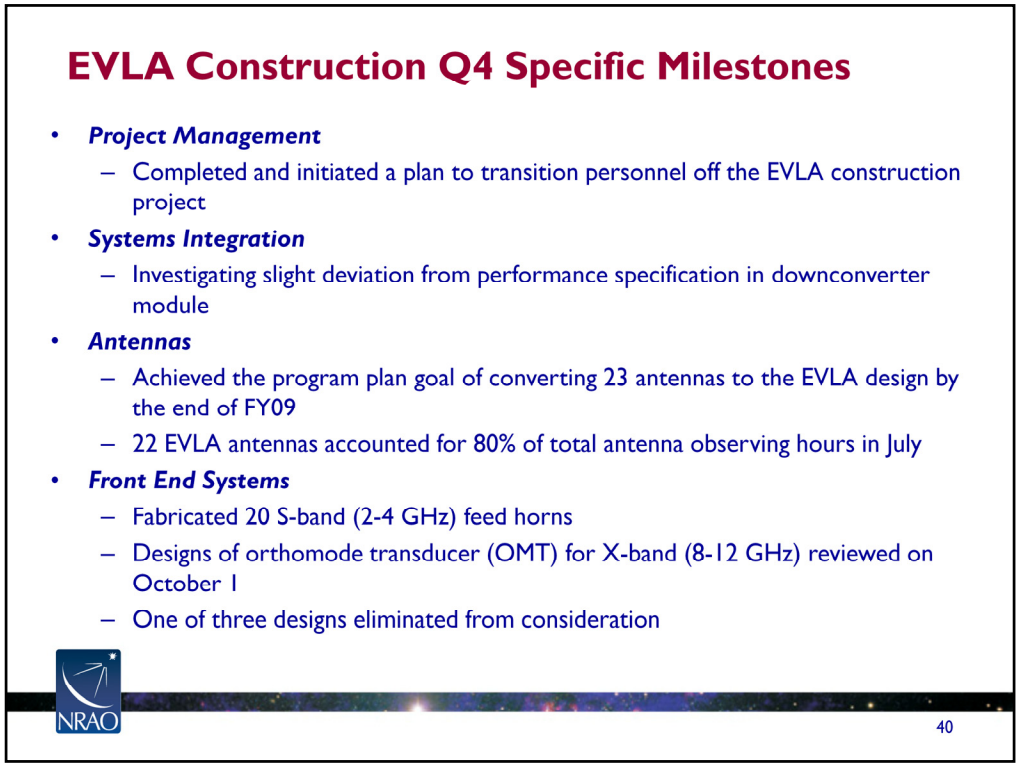
Very Large Array (VLA)/Expanded Very Large Array (EVLA)

- The content was provided by
  - New Mexico operations management
  - EVLA project Team
  - NRAO Business Services
- VLA and EVLA project tracked and presented to NSF through SPO 1



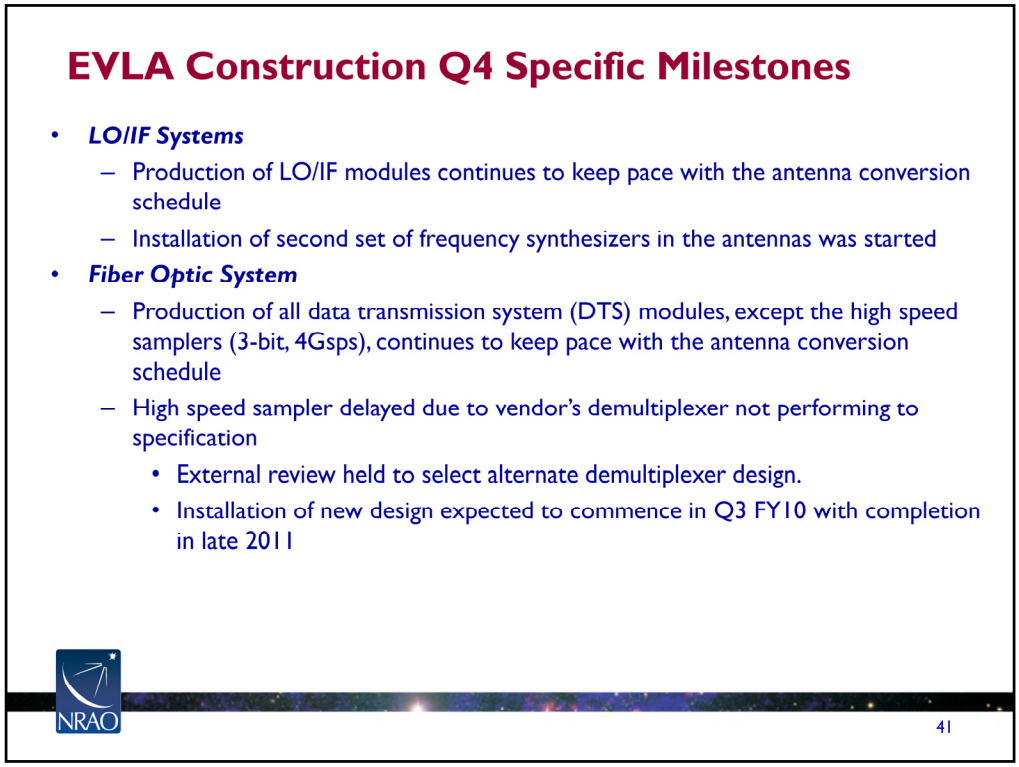
The first graph illustrates the full lifecycle. The second graph is this fiscal year view. The vertical line represents where we are today. The CP represents the critical path.

The EVLA project remains on schedule. The installation of the WIDAR correlator is on schedule for completion in Q1 CY2010. The conversion of antennas to the EVLA design is scheduled to be complete in Q3 CY2010. The last EVLA receiver will be installed in late CY2012. The critical path to project completion currently runs through the conversion of the antennas to the EVLA design and will move to receiver production at the start of FY2011.



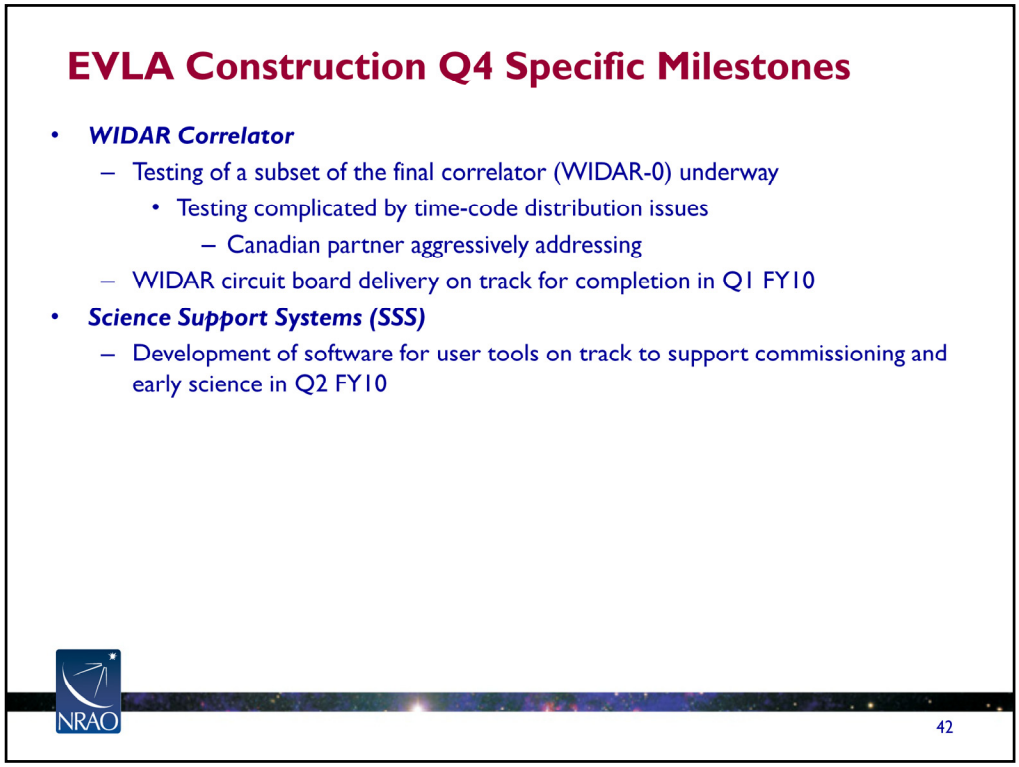
The project contingency, as estimated by the Project Management office from updates of the WBS cost data sheets, has improved over the last three years and remains at historically high levels. The project management office **completed and initiated a plan to transition personnel off** the EVLA construction project budget.

The **Systems Integration** group is investigating the EVLA's main downconverter for a slight deviation from its performance specification. The bandpass from the downconverter is not as flat as it should be. The cost of the downconverter modification is expected to be minor, and its implementation should not affect the overall project schedule. **Achieved the program plan goal** of converting 23 antennas to the EVLA design by the end of FY09. 22 EVLA antennas accounted for **80% of total antenna observing hours** in July. During Q4, **20 S-band (2-4 GHz) feed horns were fabricated**. The fabrication of the S-band feed horns appears in **the Front End portion** of the project's work breakdown structure. The completion of the horn fabrication is a program plan goal for FY10 and should occur in early April 2010. The horns are being completed well in advance of the S-band receiver deployment schedule. The on-antenna performance of prototype Ku-band (12-18 GHz) receiver exceeds design specifications. The X-band receiver is the last receiver to be installed on the EVLA antennas. Designs of orthomode transducer (OMT) for **X-band (8-12 GHz) was reviewed on October 1** and one of three designs eliminated from consideration. Its mechanical design awaits the selection of the final OMT design (The mechanical design of all other EVLA receivers is complete). This decision has been complicated by recent operational concerns regarding seemingly long cool-down times for the receiver. The OMT design will be selected in Q1 FY10 so that receiver production can commence in Q2.



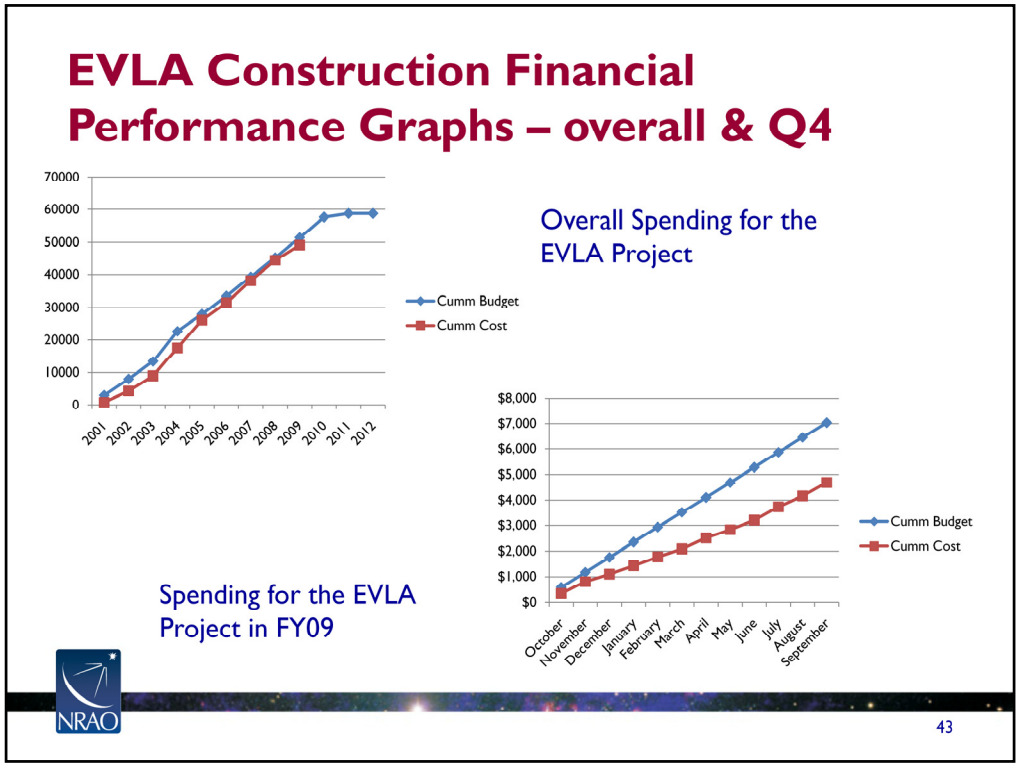
Production of LO/IF modules continues to keep pace with the antenna conversion schedule. **Installation of second set** of frequency synthesizers in the antennas was started. The second set of frequency synthesizers in the LO/IF system is used in the wide band signal path of the EVLA. In conjunction with the high speed samplers (see the fiber optics discussion), they enable observations at 8 GHz bandwidth per polarization. The synthesizer installation is being done well in advance of the sampler installation. To date, synthesizers have been installed in three antennas, with a future installation rate expected to be one antenna per month.

The high speed samplers (3-bit, 4Gsps) samplers in the EVLA's **Fiber Optic System** enable high bandwidth (8GHz per polarization) observations. Although the prototype version of the demultiplexer used in the sampler was shown to work in the summer of 2007, subsequent versions of the vendor's demultiplexer have not performed satisfactorily. After over a year of investigation into the problem, work on the current demultiplexer design was suspended, and an external review was held on October 13 to select an alternate design. A new design, based on a field programmable point gate array (FPGA) – a technology that was not available as recently as a year ago – was selected, and the detailed design of the sampler is underway. Currently, the sampler installation is expected to commence in Q3 FY10 with installation complete in late 2011. This sampler installation plan should not adversely impact the overall project schedule.



The VLA correlator is scheduled to be replaced by the WIDAR correlator in January 2010. A subset of the final correlator, called **WIDAR-0,** is being used now for systems integration tests of the correlator. **Tests** are focused on the correlator configurations that will be used for the first set of science observations in early CY10. Data were recorded in all four polarization products with WIDAR-0 for first time in July. The method used to distribute **time code** to the various boards in the correlator introduced excessive jitter on the code, which adversely affected correlator operation. The EVLA Canadian partner is aggressively addressing the time code issue. For now, we do not believe that this issue will delay the shutdown of the VLA correlator. The delivery of WIDAR's station boards should be complete in November 2009, and all baseline boards should be delivered by March 2010. All WIDAR crossbar boards were delivered and installed in August 2009. Sufficient number of boards on hand now for early science observations. Current development for Monitor and Control Systems is focused on systems integration of WIDAR.

In the Science Support Systems (SSS) area, **development of software for user tools are on track** to support commissioning and early science in Q2 FY10.



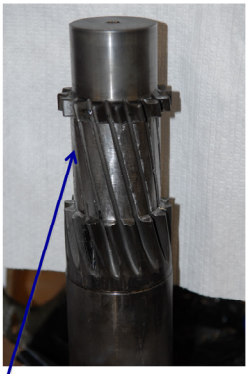
Project spending is slightly behind schedule due to delayed deployment of the high speed samplers and the X-band receiver. The production and installation of these devices should commence in FY10. Since the full capability of the data post-processing computer and correlator backend computer is not needed now and for initial observations in early CY10, the procurement of these computers has been postponed to take advantage of the trend of higher performance computing becoming available at significantly reduced prices in the future. Adequate computing is on hand now, and the lead time to purchase computer components is small (about two weeks).

EVLA Science Operations Q4 Significant Events

- Commissioning has focused on testing and system integration of the WIDAR correlator
  - Emphasis is on correlator configurations that will be made available for EVLA Early Science in March 2010
  - Includes user documentation and modifications to the Proposal Submission Tool to accommodate observations with WIDAR
- Call for EVLA proposals was made on September 15

VLA Operations: Q4 Significant Events (I)

- ***Antennas***
  - Follow up of 2/09 AZ gear box failure on antenna 5
    - Mitigation completed:
      - Accelerated antenna gear inspection + oil changes programs are now in place
      - Swapped drive and backlash gearboxes to even out wear load
      - Inspection complete: only 3 of 56 AZ gearboxes show additional serious wear; will be repaired
      - No EL gearboxes showed serious wear



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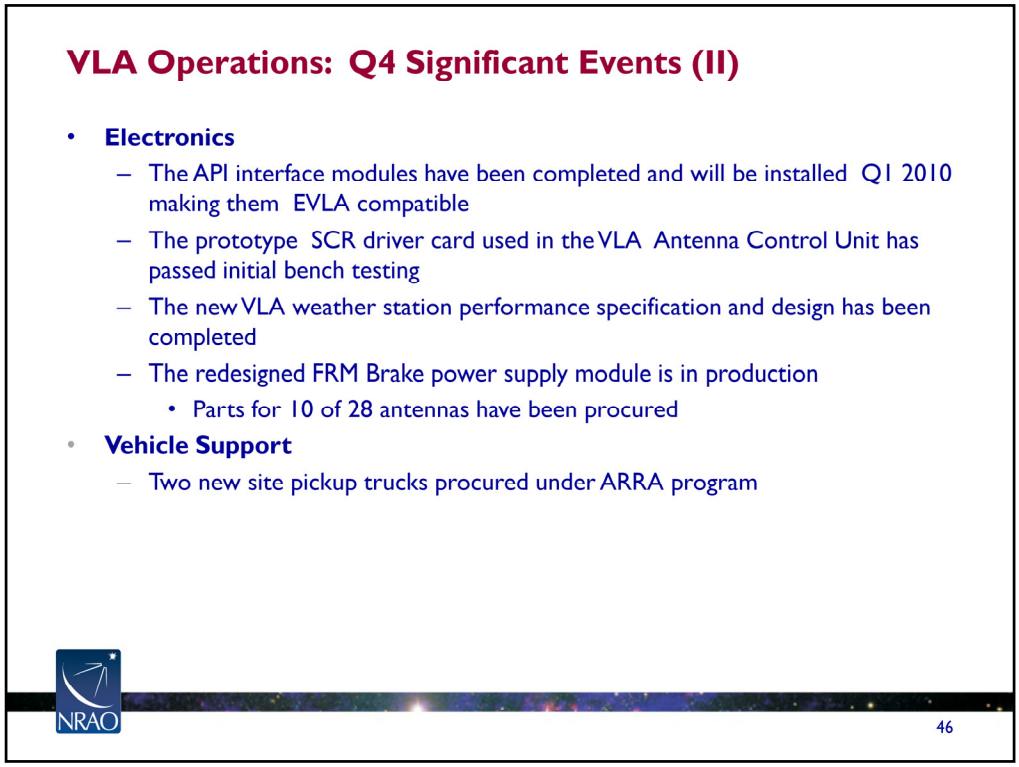
As a follow up of 2/09 AZ gear box failure on antenna 5, risk **mitigation has been completed**. Accelerated antenna gear inspection + oil changes programs are now in place. Swapped drive and backlash gearboxes to even out wear load. Inspection complete: only 3 of 56 AZ gearboxes show additional serious wear; will be repaired. No EL gearboxes showed serious wear. VLA antennas are the only major infrastructure element not addressed in EVLA modernization and they will be operated well into their 50s.



Electronics reports that the old VLA **API modules** are not compatible to interface with the new EVLA monitor and control system so new API interface modules have been completed and will be installed in Q1 2010. The aging **SCR driver cards** are antiquated and in desperate need of replacement. A program has been started to address long-term reliability. The prototype SCR driver card used in the VLA Antenna Control Unit has passed initial bench testing. Antenna test will begin in January 2010. The old **VLA Weather station modules** are not compatible to interface with the new optical EVLA system. The new VLA weather station performance specification and design has been completed. Hardware procurement contingent on funding. The aging **FRM Brake power supplies** are antiquated and in desperate need of replacement. The brakes which are presently installed in the antenna FRMs also need to be replaced. The redesigned FRM Brake power supply module is in production. Parts for 10 of 28 antennas have been procured.

In Q4, two new **site pickup trucks** were procured under the ARRA program.

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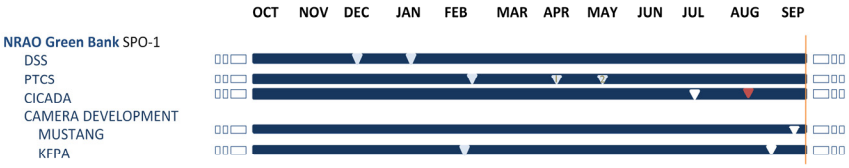
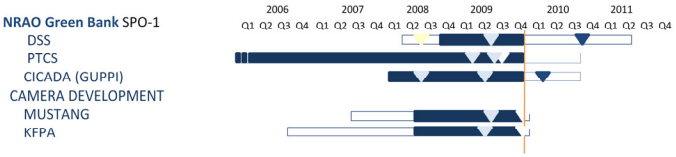
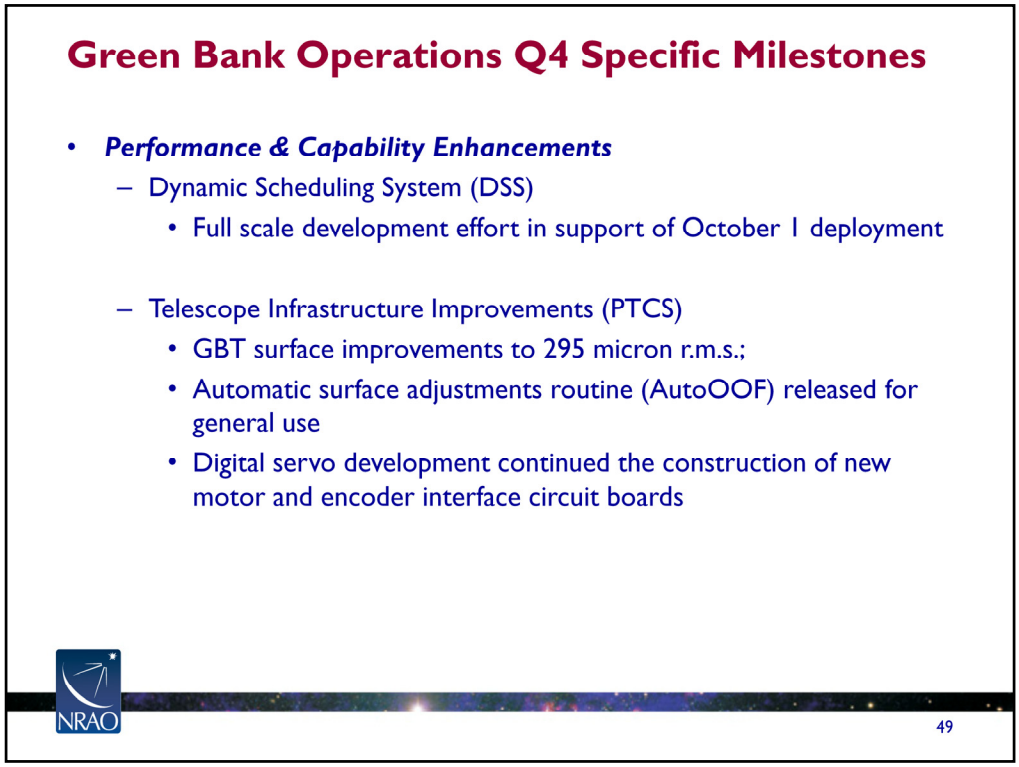
Green Bank Telescope Specific Milestones FY 2009





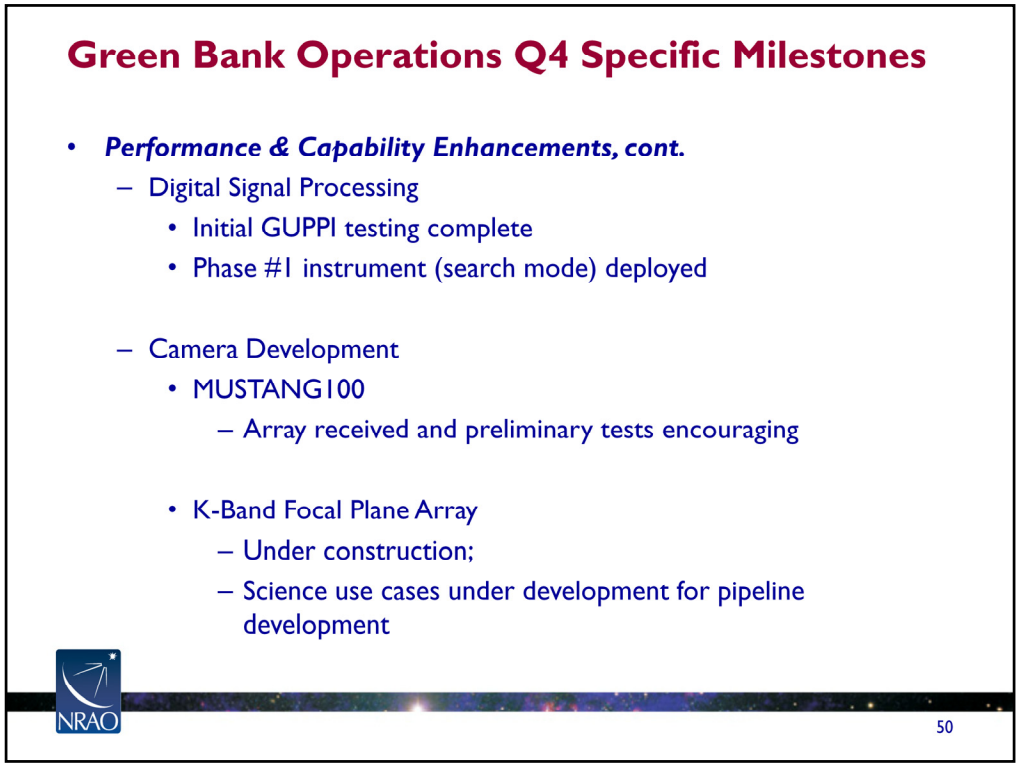
NOTE: These development activities are unrelated, therefore there is no critical path identified.



DSS: Software development continued in advance of an on-time release of the baseline functionality for GBT dynamic scheduling beginning Oct 1.

Telescope Infrastructure: The conventional holography campaign continued with mapping and surface adjustments. From these data, the control cables to two actuators were found to be swapped, and this error has been fixed. The other repair work on the actuators was also completed and the first map unaffected by failed actuators was obtained. The first manual adjustments of panel corners since the original installation of the surface was performed successfully. A total of eight discrepant panel corners were manually reset resulting in a smoother surface at the affected panels. The current best surface (295 microns rms) has been installed for use during the October-January semester.

- The software for the AutoOOF procedure has been incorporated into the GBT software tree in order to ease future upgrades.
- Servo project continued digital servo system development and construction of new motor and encoder interface circuit boards.



Digital Signal Proc. No other projects are currently funded except for the Green Bank Ultimate Pulsar Processing Instrument (GUPPI). In this quarter we finished the observing system integration and test. The instrument is released for use by all observers. A new fast-dump mode was implemented to support a new search project. Funding was restored for coherent de-dispersion mode development and the development work was resumed. Delivery for restarted effort is estimated to be February 2010.

Camera (MUSTANG) 100 pixel array received from NIST in mid-September and testing is underway with encouraging initial results. Plans call for release of the 100 pixel system for the 2009/2010 high frequency observing season. Basic offline data reduction pipeline capabilities are complete and ready for the upcoming observing season.

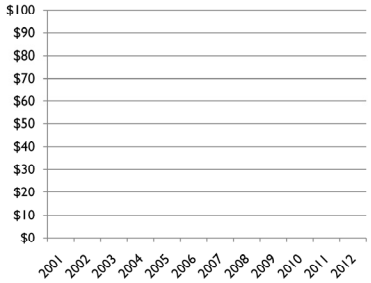
Camera (KFPA)

Receiver: All items necessary to build the receiver, except the LO doubler and distribution, were delivered this quarter. Testing of the cryogenic isolators was completed. Testing of the remaining microwave components has started. Cabling and wiring of the frame external to the dewar has also begun. The M&C hardware was built tested and a mechanical housing built.

Monitor & Control : The software, which provides the interface to the hardware was written and tested with all available devices.

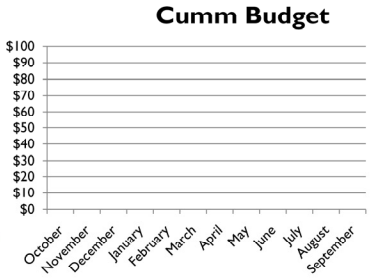
Data Pipeline: Published data illustrating the frequency-switched mapping use case was identified and test IDL scripts were written. Distilling the calibration options into a selection of priority methods to apply to the first commissioning data. Developing a strawman design for initial tests of the pipeline implementation inside of GBTIDL.

GBT Development Financial Performance Graphs – overall & Q4



Overall Spending of NSF Funds for the GBT Development

Cumm Budget
Cumm Cost



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Spending of NSF Funds for the GBT Development in FY09

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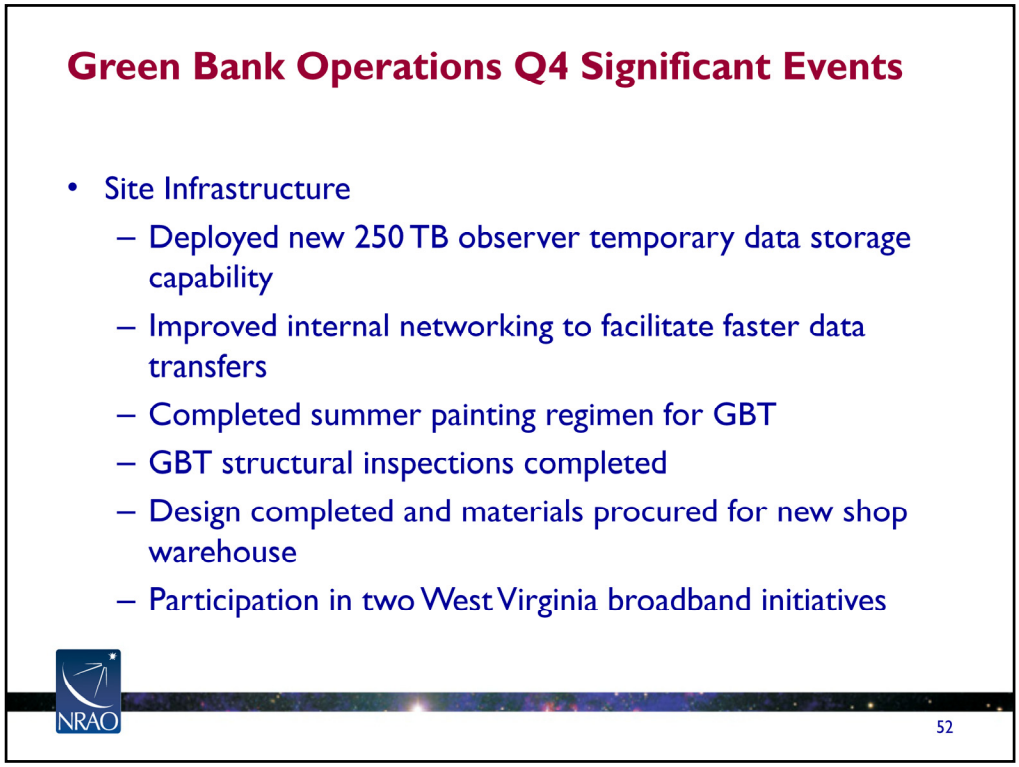
Data from the ETK system is pending. At this time, no financial data is provided.



Data Storage Enlarged the data storage capabilities at GB for temporary storage of observer data before data reduction begins. This has been long requested by the pulsar astronomers and others whom have been acquiring large data sets from their scans and observations.

Internal Network Networking speeds have been increased with the GB facility so that large data transfers can occur more efficiently and without affecting other network traffic

Painting The summer maintenance season was extended into September to allow for more of the GBT structure, including some surface panels, to be painted as part of annual maintenance

Inspections A structural inspection of the GBT was conducted and the structure was deemed to be holding up well. A few areas of corrosion were identified and re-welding or added material returned the areas to original design strength.

GB Warehouse A design was completed and the materials procured for a new warehouse to be built in the GB shops area. This new facility, shared by the shop and plant maintenance divisions will allow for moving of materials stored in the shop work area to a safer location and the indoor storage of materials for both divisions.

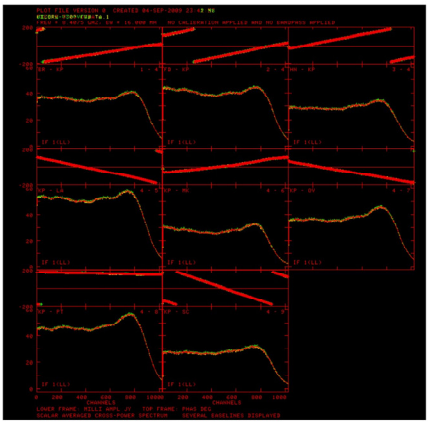
Broadband Green Bank participated in submittal of two broadband internet access applying for grants under the federal government economic stimulus program to provide broadband internet access to the Observatory, local schools, local library and the community. A third submittal with another partner is planned for the fall.

Agenda

- Science Results/Metrics
- Observatory Science Operations
- Site Specific Activities
  - ALMA
  - VLA/EVLA
  - GBT
  - VLBA
- Observatory-wide Operations

VLBA Operations Q4 Significant Events

- ***Antenna Maintenance***
  - Los Alamos
    - S/X Dichroic Panel replaced
  - Mauna Kea
    - Azimuth Wheel Assembly replaced
- ***Correlator, Recorders and Playback Units***
  - DiFX Software Correlator
    - Operator GUI completed.
    - Initial functional tests completed
    - DiFX accepted for use in trimester 2010-A
  - Mark 5C Recorder
    - Control application functionality and command set defined.
    - Supplemental vendor tasks specified
- ***Electronics***
  - DBE/Mark5C racks installed at MK, LA, FD



DiFX and VLBA correlators compared

NRAO

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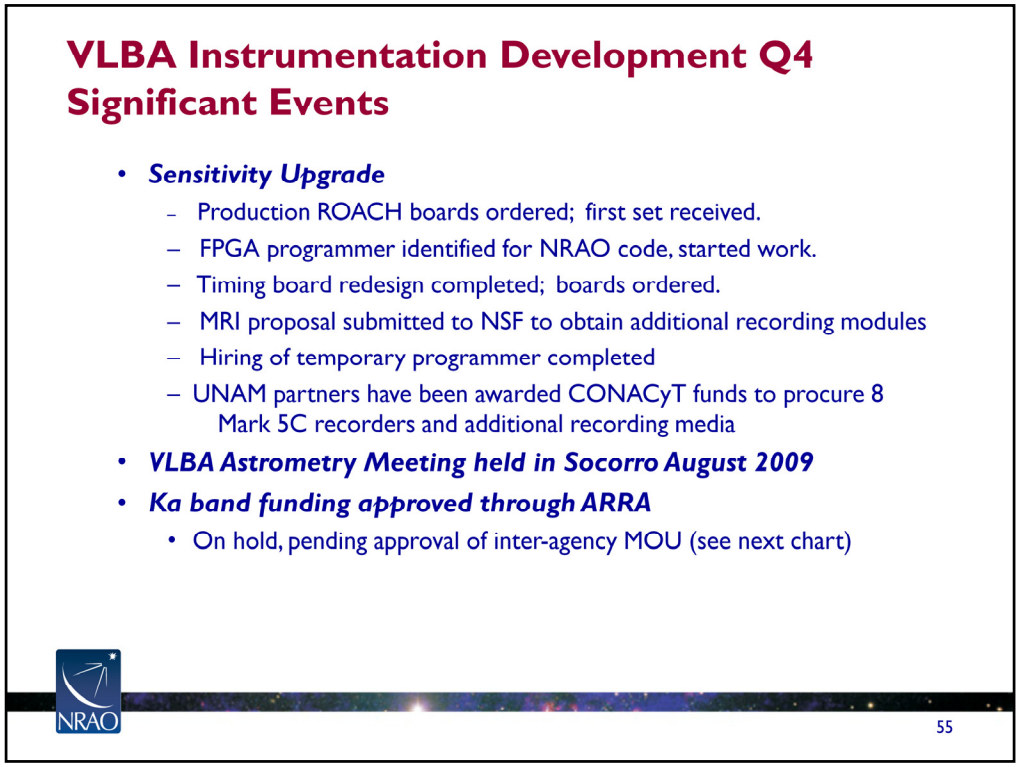
In Q4, The VLBA underwent **standard maintenance** at the Los Alamos and Mauna Kea sites.

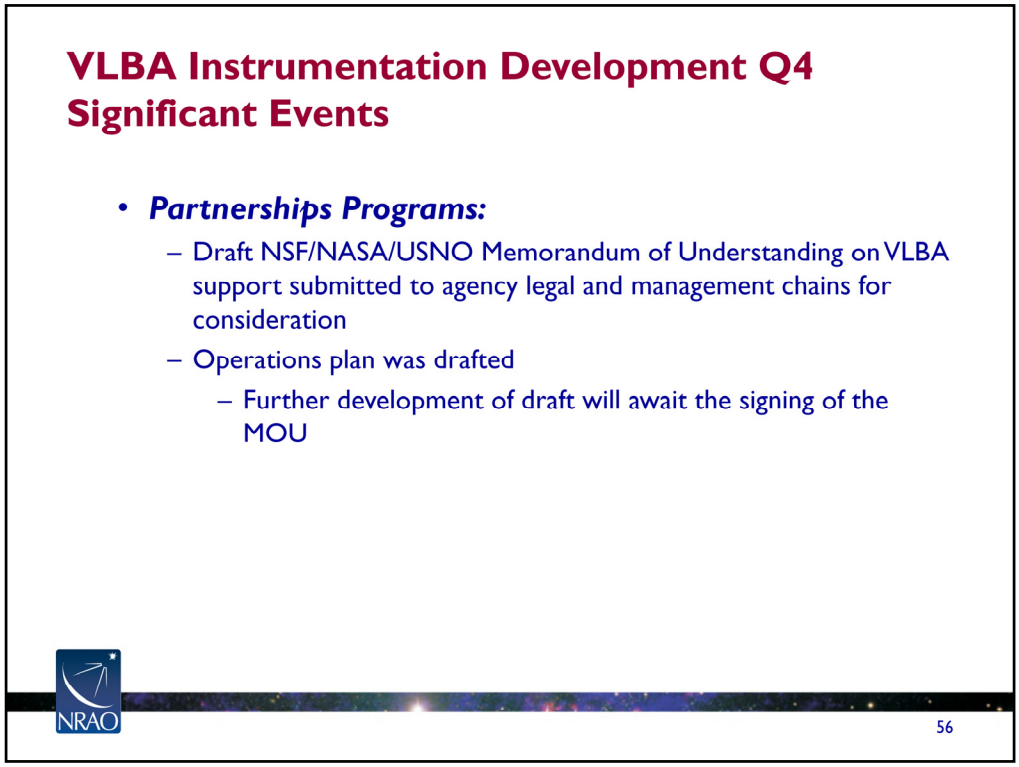
During the first three quarters of FY09, the VLBA underwent **additional sensitivity enhancement** activity under non-programmatic funds to demonstrate a goal of 4 Gbps data rate. During this time period, the hardwired correlator was replaced by DiFX 'software' correlator. In Q4, full testing of the DiFX software correlator took place, with the goal of replacing the existing hardware correlator by the end of Q1 FY 2010. The initial functional tests are a subset of those specified in the DiFX Test Plan, which could be carried out in the current state of DiFX. They are considered sufficient to accept DiFX for routine operational use. The DiFX and hardware comparisons plot visibility amplitudes and phases for selected VLBA antenna baselines in the input data set. Green points are DiFX results, yellow are from the old VLBA hardware correlator, and red is used for points that are indistinguishable in the plot. Numerically, the data show excellent agreement in amplitude to (0.4%±1.7%), and in phase to (0.1°±1°). The tests were highly successful, with data from the two correlators agreeing in amplitude to (0.4%+-1.7%) and in phase to (0.1 degree +- 1 degree).



Haystack FPGA code refers to the polyphase filterbank FPGA personality for which Haystack Observatory is responsible under NRAO/Haystack collaboration.

NRAO code refers to the digital downconverter personality for which NRAO is responsible. The newly identified **FPGA programmer** will work under supervision of the senior engineer originally expected to carry out this development.

The **supplemental vendor tasks** originally were not required as early as FY 2010, but have been found necessary to support NRAO's short-term goal of 2-Gbps recording.



The **NSF/NASA/USNO MOU** has been extensively iterated among partners before submission to management chains. An **operations plan was drafted,** laying out concept for issues such as telescope time allocation, procedures for communication, data delivery, priorities, and responsibility for carrying out different activities. Intended to be one of several documents (e.g., interface requirements) supporting execution of the MOU. Further development of draft will await the signing of the MOU.

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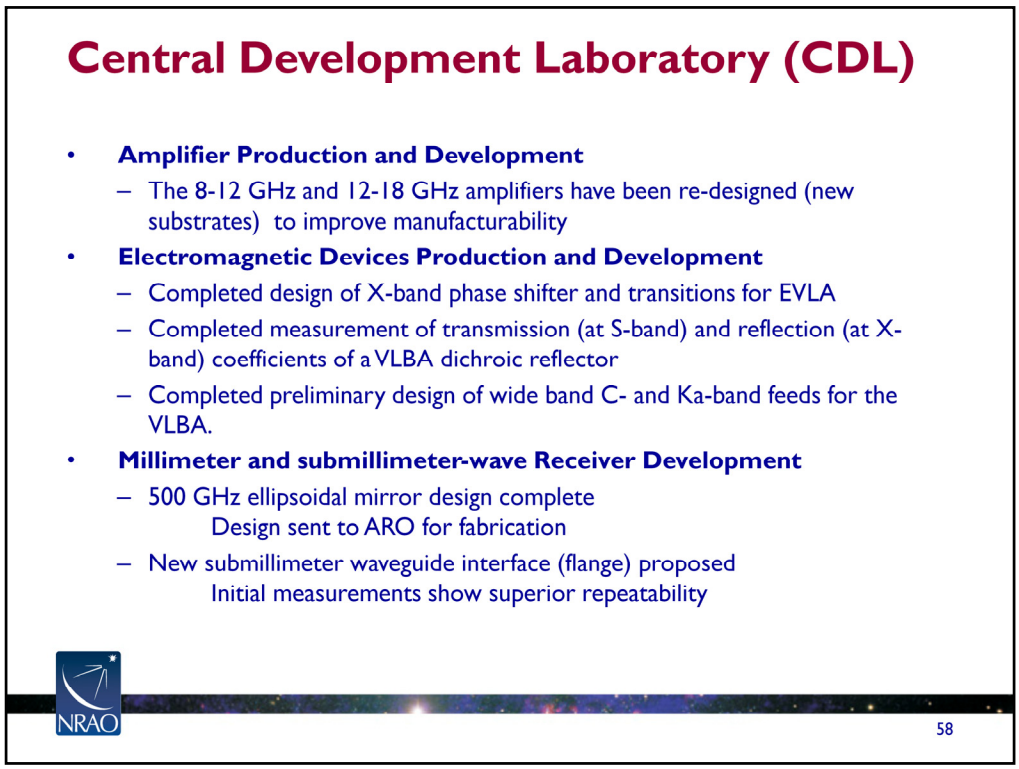
  - Spectrum Management
  - Science and Academic Affairs
  - Computer & Information Systems
  - Management & Administration Infrastructure

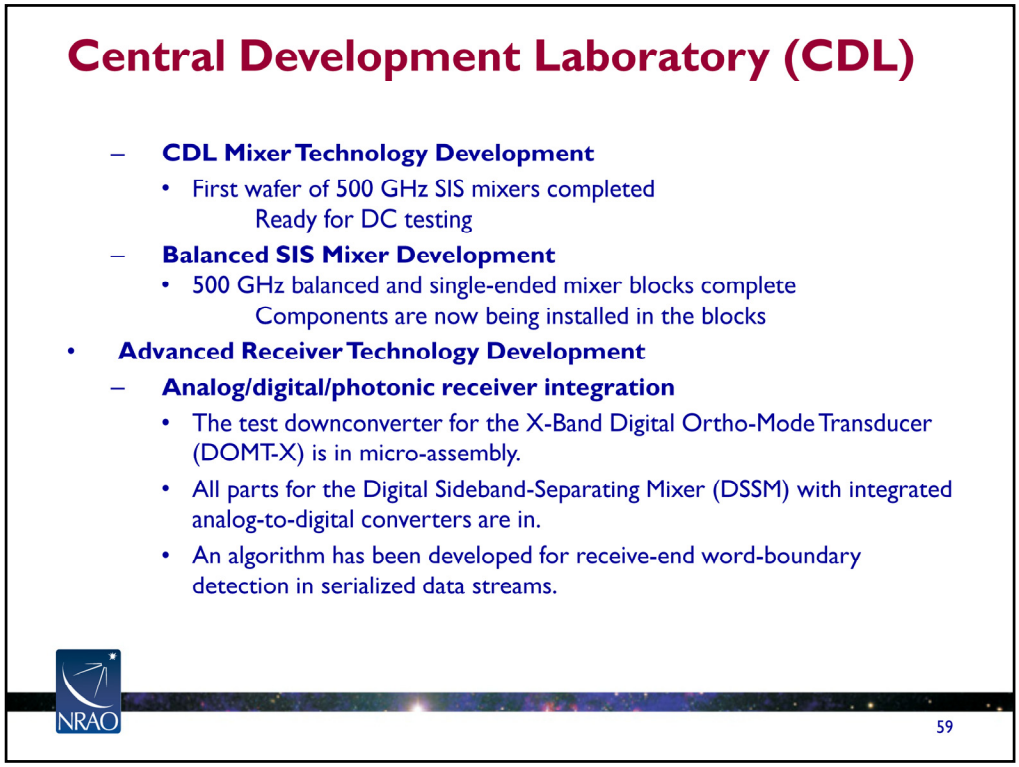


Amplifier Development: The design of demonstration amplifiers for ALMA band 1 (31-45 GHz) and band 2 (67-90 GHz) receivers has been completed. Research on noise properties of heterostructure bipolar transistors (HBTs) and CMOS MOSFET continues.

Amplifier Production Milestones: New amplifier production included four 1-2 GHz low noise, four 1-2 GHz high dynamic range, four 2-4 GHz, one 18-26 GHz, six 26-40 GHz and one 38-50 GHz amplifiers. Repair, upgrade, and retesting of amplifiers included two 1-2 GHz, five 4-8 GHz, one 4-12 GHz, two 8-18 GHz, four 18-26 GHz amplifiers. In total, 34 amplifiers were shipped. The EVLA amplifier production is slightly behind schedule; however, no impact on the EVLA receiver production is expected. The deliveries of 18-26 GHz and 38-50 GHz amplifiers in support of Korean VLBI network, MPI Receiver Group and JPL DSN are on schedule.

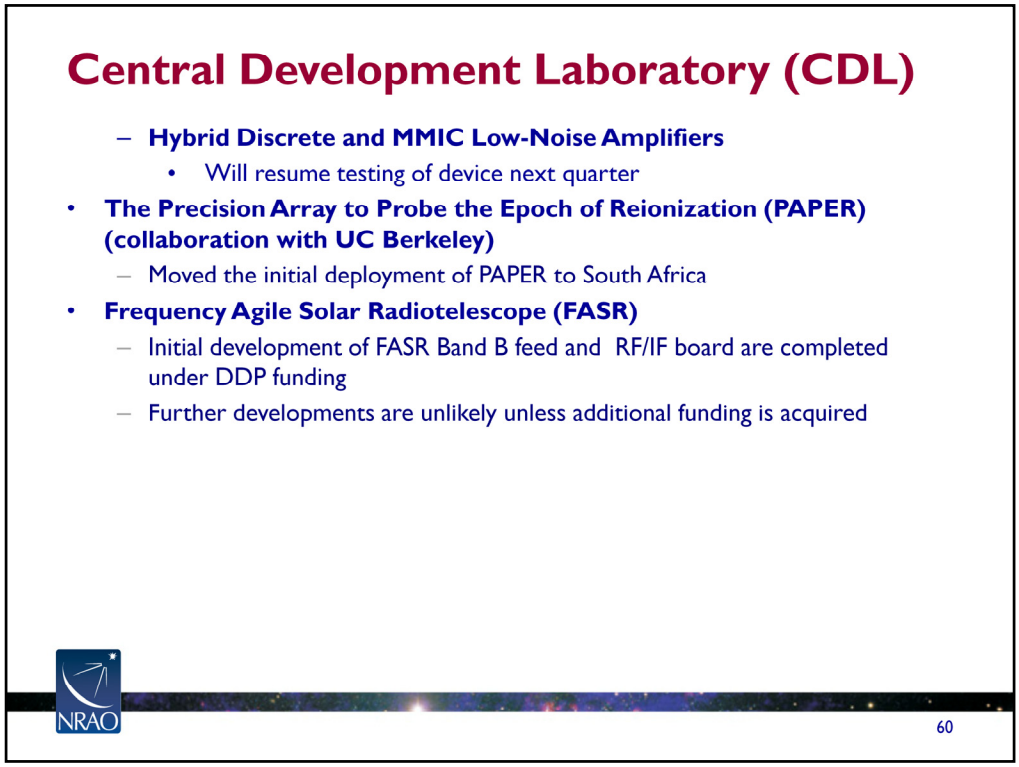
Electromagnetic Devices Production and Development: Measured input match of eight EVLA K-band feeds. Measured far-field patterns of an EVLA Ku-band feed horn at the Green Bank Outdoor Antenna Range. A second version of the **EVLA X-band** Turnstile Junction orthomode transducer was analyzed. Completed measurement of **transmission (at S-band) and reflection (at X-band)** coefficients of a VLBA dichroic reflector. Completed preliminary design of **wide band C- and Ka-band feeds for the VLBA**.

Submillimeter-Wave Receiver Development: The cryogenic test system for SIS receivers at 500 GHz is nearly complete. This includes the DC bias and IF components, optics, and LO and signal sources. An **ellipsoidal mirror design** is complete and has been sent to our collaborators at the Arizona Radio Observatory for fabrication. A proposed **submillimeter waveguide interface (flange)** has much greater alignment precision than the standard UG-387 type of flange while being backward compatible with the old standard. Initial measurements in collaboration with UVA show greatly improved repeatability of the new design.

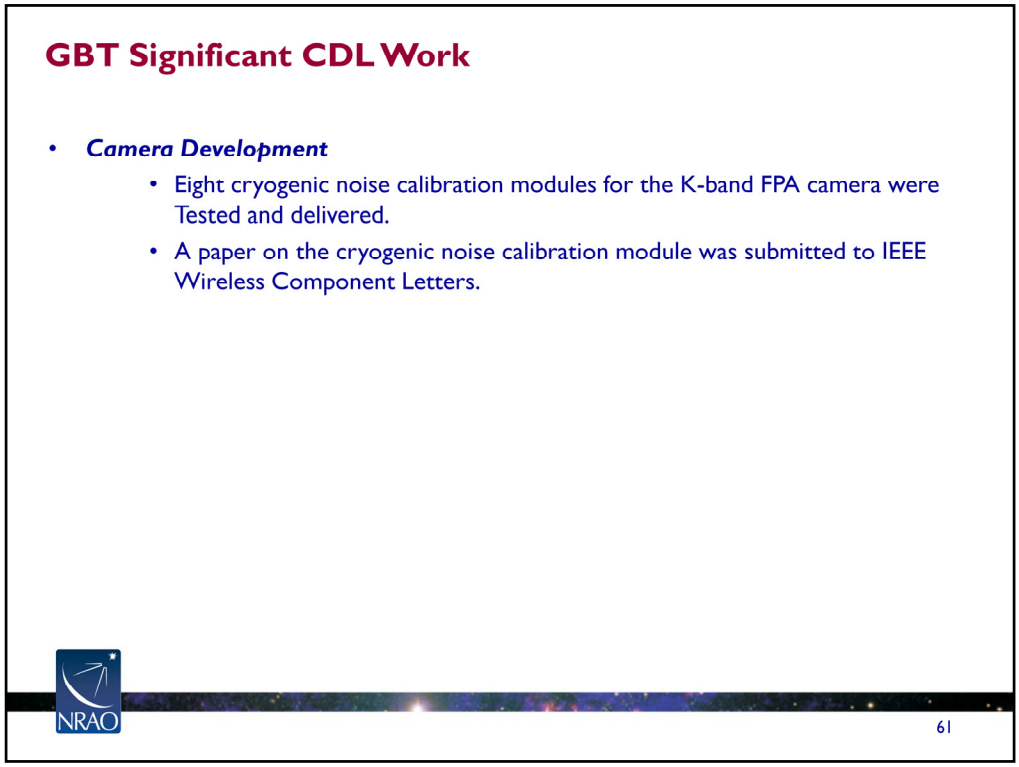


CDL Mixer Technology Development: Work continues towards a 350-μm SIS mixer. At the University of Virginia Microfabrication Laboratory (UVML), under an NRAO contract, AlN SIS junctions with very high critical current density were demonstrated in the last year, and work continues towards a stable and reproducible process. Also at UVML, work continues on the fabrication of high quality NbTiN for use above ~700 GHz. While UVML develops the new materials and fabrication processes, the CDL is prototyping the 350-μm mixer at half the frequency to optimize a new mixer design using silicon membranes and gold beam leads. The **first wafer of 500 GHz SIS mixers** has been completed at UVML and is awaiting measurements. **Balanced and single-ended mixer blocks** have been fabricated at the CDL.

Analog/digital/photonic receiver integration: Now with limited technician support, the **downconverter for testing the X-Band Digital Ortho-Mode Transducer** (DOMT-X) is in micro-assembly. All the parts for the **Digital Sideband-Separating Mixer (DSSM)** with integrated analog-to-digital converters are in. An algorithm has been developed for **word-boundary detection of Gaussian-distributed, white-noise data streams** at the receive end of the link. An analysis of the algorithm's performance shows that word boundaries can be detected with very high statistical certainty in a short time, even in the presence of real-world non-Gaussian signals such as RFI, and non-white spectra due to gain slopes. This should permit using very simple digital data sample stream transmission without formatting and deformatting electronics, reducing expense and heat dissipation. An Electronics Division Technical Note (EDTN #213) describing this work has been released.



PAPER: It was recently decided to move the initial deployment of PAPER to South Africa for two reasons: 1) to help the MWA project by staying out of their way during this very critical time for them; and 2) our correlator engineer is in South Africa and this is a critical time for us to develop a 64 station, dual-polarization, ROACH-based correlator. We plan to revisit the site question once we have 64 stations deployed. Eventually we plan to join the MWA group as we move toward the next generation instrument (HERA II).



Noise calibration on cryogenic radio astronomy receivers has traditionally been performed using commercial noise diodes placed outside the cryostat, routed through an attenuator into the Dewar, and injected into the signal path before the cold LNA through a coupler. For a focal plane array (FPA) receiver, or camera, this method of noise injection vastly complicates the cable and waveguide routing inside the cryostat as well as adding extra Dewar feedthrough transitions. It is highly desirable to integrate the noise generator with the coupler on the cold stage, eliminating all the associated cabling. Also, integrating the noise source with the noise coupler results in less power-*vs*.-frequency structure and therefore more accurate calibrations. Another advantage of this type of noise calibration is that the voltage bias of the commercial MMIC LNA used here as the noise source can be adjusted to provide many different levels of injected noise, which can be optimized for different types of observations. In this quarter, **eight cryogenic noise calibration modules for the K-band FPA** camera were tested and delivered. A paper on the cryogenic noise calibration module was **submitted to IEEE Wireless** Component Letters.

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New Initiatives

- Square Kilometre Array
  - Detailed responses to Astro2010 questions were submitted by the US SKA Consortium (SKA) and NRAO (North America Array)
  - NRAO participated in preliminary discussions and the face-to-face meeting of the Funding Agencies tiger team on the SKA schedule
  - Final negotiations were concluded for a long-term collaboration visit to South Africa by an NRAO scientist, to facilitate cooperation in digital design, algorithm development, and SKA commissioning
- Lunar Radio Astronomy
  - Designed and built a rugged, dual-polarization dipole reference antenna, completely encapsulated in PVC tubing, for 137 MHz (HI at redshift z=9.3)
  - Examining planar ground screen with fan-fold deployment mechanism for robust deployment on lunar surface

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SKA - Steve Myers led the NAA submission to Astro2010. Ulvestad was invited to become a full member of the schedule tiger team based on his contributions as a consultant. Shepherd has arrived in South Africa, and other South Africa visits are under way, to make collaboration more concrete. Results on this will be reported next quarter.

LRA - This is all Rich Bradley's work. A photo of the 137 MHz antenna is available.

Space VLBI —Japanese mission has been under cost/technical review and is on hold pending results, so no activity here.

LWA - NRAO only participates on a reimbursable basis, plus some individuals on their science time. Future funding of the LWA is very much in doubt, and it is quite possible that the whole effort from UNM and the Southwest Consortium will disappear in a year or so.

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Education and Public Outreach

News and Public Information

- Press Releases
  - Super-energetic bursts near giant black hole, 7/2/09
  - Measurement of curvature of space, 9/1/09
  - Pulsar-like object discovered by high school student, 9/22/09
  - ALMA first antenna to high site, 9/23/09
- Science Media Services & Outreach
  - Fulfilled several requests for NRAO HD video footage by broadcast documentary producers
- Public Web Site
  - Produced video for NRAO website & YouTube celebrating Pulsar Search Collaboratory student discovery

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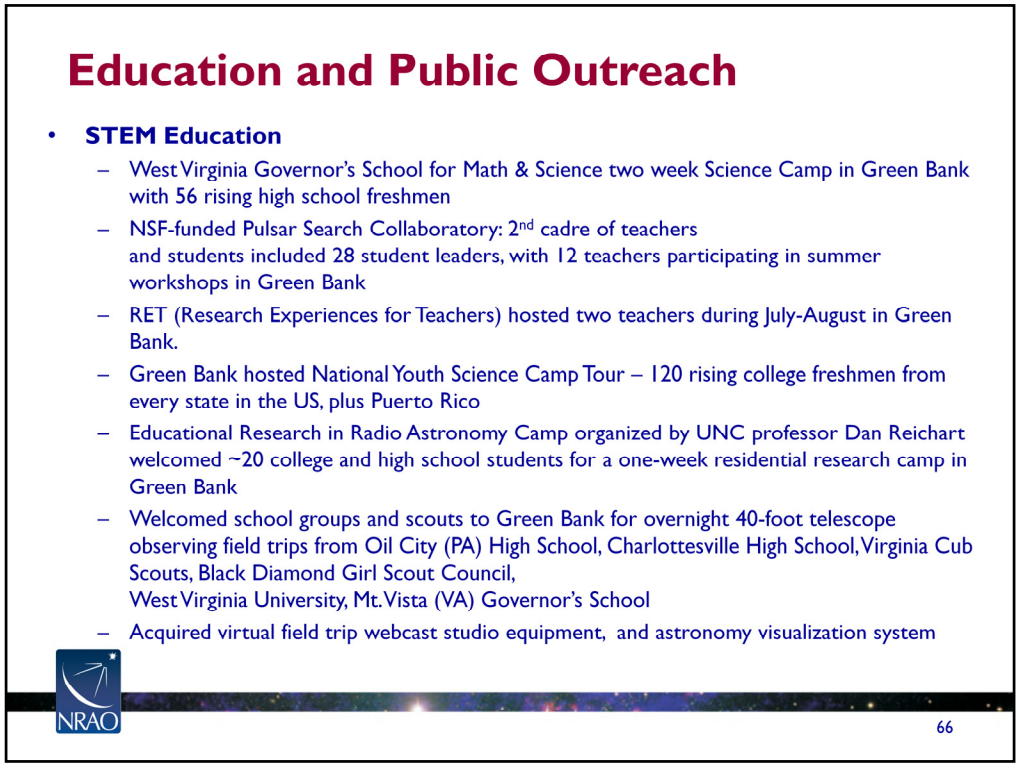
Referenced **Press Releases** can be found at
http://www.nrao.edu/pr/2009/m87gamma/
http://www.nrao.edu/pr/2009/gravity/
http://www.nrao.edu/pr/2009/pulsarstudent/
http://www.nrao.edu/pr/2009/antennahigh/

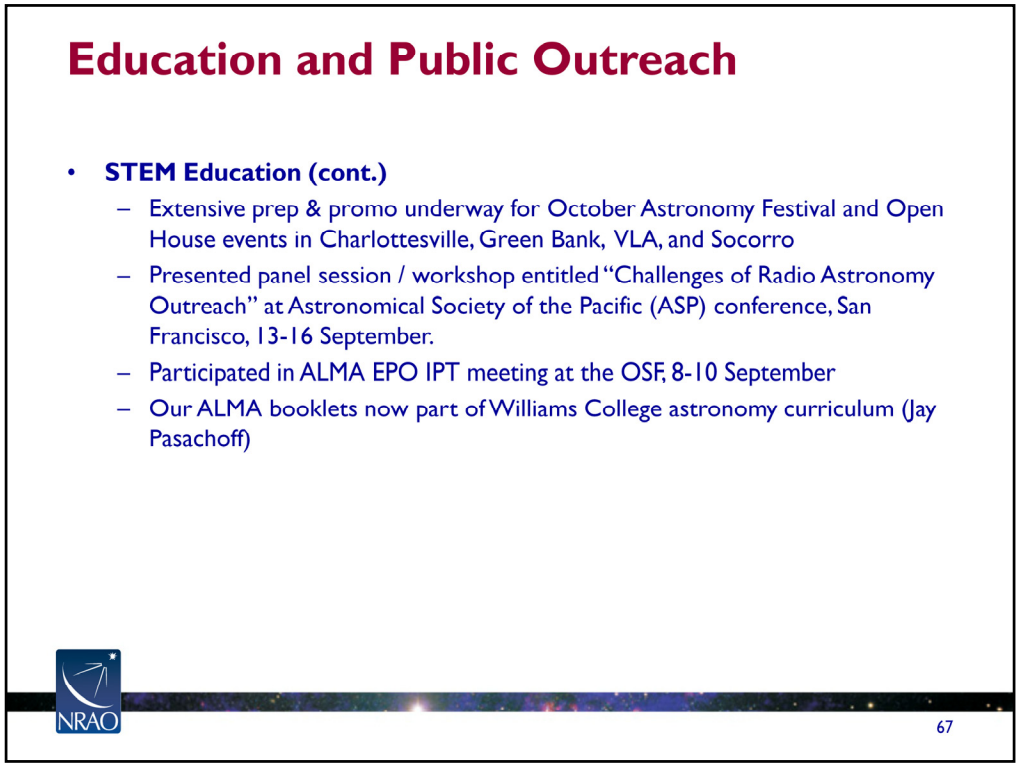
Requests for use of NRAO HD video footage noted under **Science Media Services & Outreach** were received from
Brook Lapping Productions (making PBS documentary on history of telescope entitled "A Quest to See Infinity" for NOVA)
Pioneer Productions (making documentary called "Engineering the Universe")
Verisocpe Pictures (making a documentary entitled "Search for Intelligent Life")
NSF's Office of Legislative and Public Affairs (OLPA, making a short ALMA video).

The YouTube video noted under **Public Web Site** can be seen at http://www.youtube.com/watch?v=e10rfn3vLbg. It was produced internally using our new HD Video production capability, a first for NRAO.



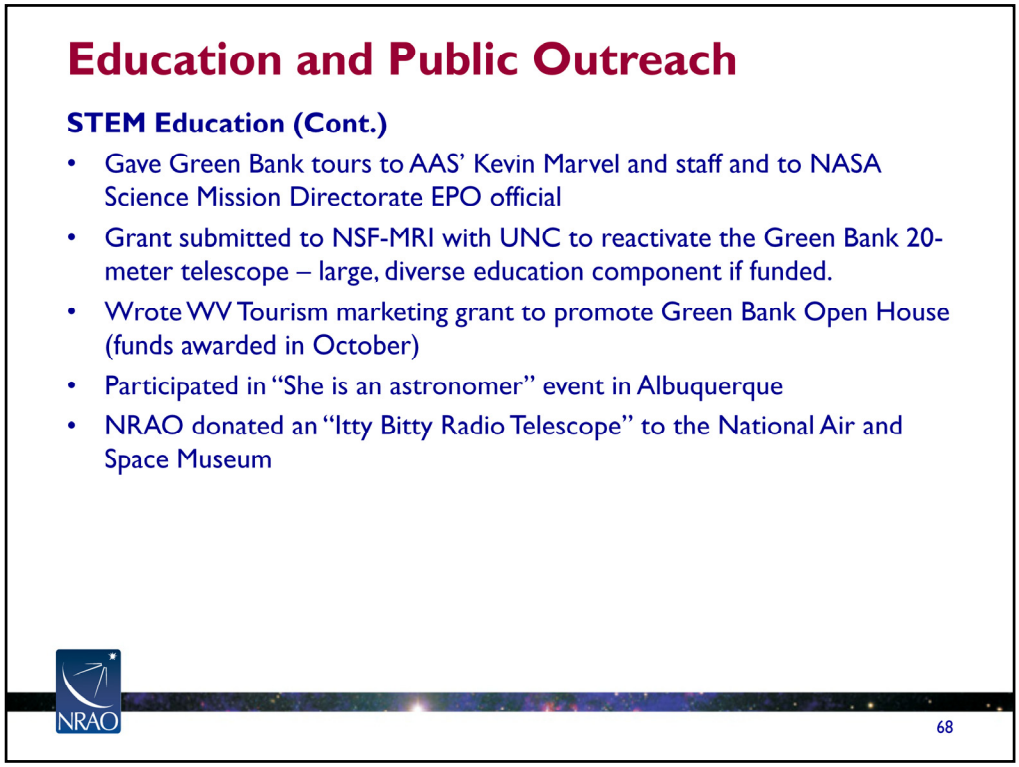
Science, Technology, Engineering and Math (STEM).

The new **virtual fieldtrip webcast studio** equipment, consisting of a special purpose video computer, lighting, cameras, microphones, software, green/blue screen backgrounds will enable NRAO to produce and present hybrid live/pre-recorded educational presentations to classes and groups/audiences that cannot practically visit our facilities. This will help to broaden the geographical impact of our educational programming. The **new astronomy visualization system**, which uses a software engine that lies at the heart of $1M+ hemispheric digital planetarium projection systems, will enable us to visualize the location of objects studied by NRAO telescopes and scientists in the night sky and in the 3-dimensional universe. This new tool will contribute to our ability to more richly illustrate press releases and other informative, educational programming. The new ViewSpace displays for the Green Bank and VLA visitor centers will enable us to inexpensively present information about other NRAO facilities, and ongoing NRAO research and discoveries, at those centers, helping to convey the larger picture of "one NRAO." We will also be using the ViewSpace network to deliver NRAO content and messages to over 200 other science museums and planetariums.



Prep for Open House events, which take place at the VLA on 3 October, in Charlottesville on 11 October, in Socorro 14-17 October (Enchanted Skies Star Party), and in Green Bank on 25 October. An additional event in Socorro occurred on 26 September, the M Mountain Fly-In. NRAO had a booth there and the event was attended by 500+ people. Also hosted Hosted Northern Virginia Astronomy Club "Almost Heaven" Star Party in Green Bank. Abstract for **ASP panel session** presented by Heatherly and Stoke.

The **ALMA EPO IPT** meeting gathered EPO representatives from the ALMA executives and the JAO, along with the ALMA director, for several days of discussions. Important topics discussed included planning for the April 2010 press/vip event at the JAO, planning for a visitor center at the JAO, policies on joint press releases, EPO conceptual "building blocks," and branding. The significance of the use of our **ALMA booklets** (prospectus for science communicators) in Astro 101 classes at Williams College is that the instructor, Jay Pasachoff, is author of descriptive astronomy text books used in many locations. We will be endeavoring to capitalize on this interest, and extend it to other NRAO facilities.



Smithsonian: NRAO donated an "Itty Bitty Radio Telescope" to the **National Air and Space Museum** (NASM, on the national mall). It will be used in educational programs conducted in and adjacent to the museum's new optical observatory on the plaza outside the museum. This will be the beginning of more extensive collaborations with NASM.
Pictures: http://alma-epo.smugmug.com/Other/NRAO-at-Smithsonian-NASM/9434385_f5EAH#632551801_ubxm8
PASSWORD: NASM-NRAO.

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A complete **re-design of the NRAO science web site** was initiated. An extensive review of the design, structure, navigation, and content of science websites at comparable observatories (e.g., HST, Chandra, Spitzer, ESO, NAOJ, NOAO etc.) was conducted. A beta site for the construction and test of the new NRAO science web site was created. The design, structure, and content of the new web site home page, and the landing pages for ALMA/NAASC, GBT, VLBA, and EVLA were completed and reviewed with the OSO Working Group. In collaboration with the NRAO web masters, Stefan Witz and Pat Murphy, tests were conducted of the Joomla, Zope, and Drupal content management systems.

The **NRAO exhibition at the International Astronomical Union General Assembly (IAU GA)** in Rio de Janeiro, Brazil (3-14 August 2009) provided an excellent opportunity to present and discuss NRAO capabilities and opportunities with many of the 2100+ astronomers from around the world who attended, including numerous young South American scientists. The **NRAO exhibition at the International Conference for High Performance Computing, Networking, Storage & Analysis (SC09)** will mark our debut in this forum as an exhibitor and is a collaboration of the Communications and the Computing Information Systems teams. The SC09 conference will be at the Oregon Convention Center (Portland, Oregon) 14-20 November 2009, with an expected attendance of ~ 10,000 scientists, engineers, software developers, CIOs, and IT administrators from universities, industry, and government agencies. **Exhibit re-design, program and NRAO Town Hall planning was initiated for the next American Astronomical Society (AAS)** meeting, which will be held 3-7 January 2010 in Washington D.C. A record AAS meeting attendance of ~ 3500 scientists is expected.

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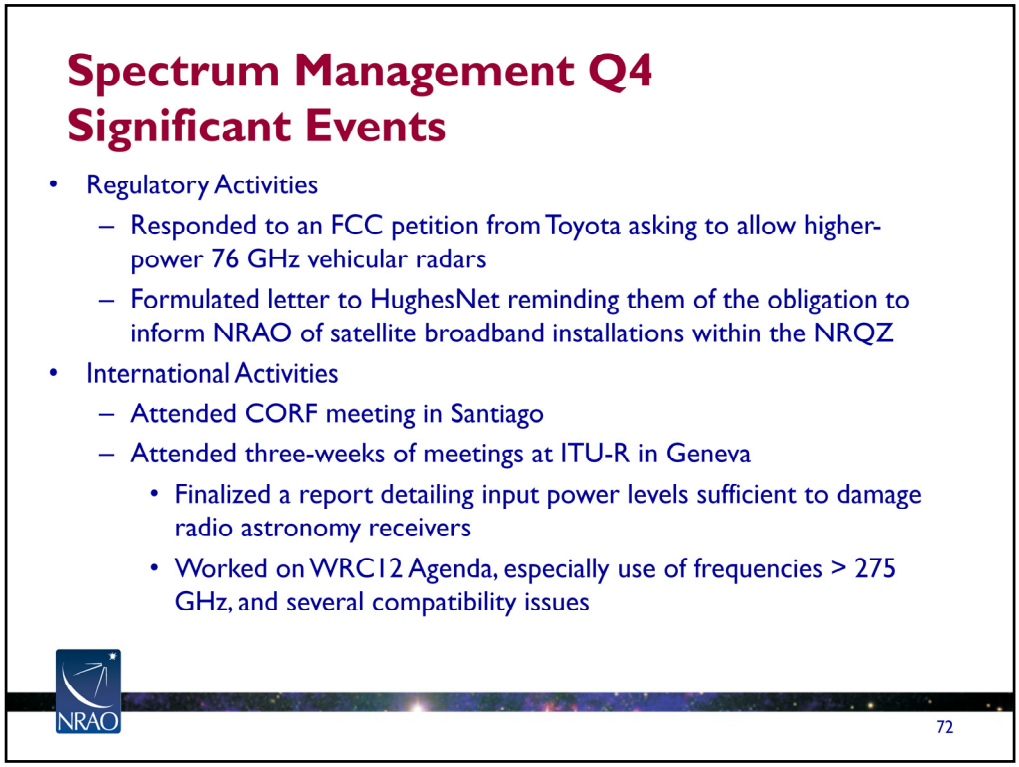
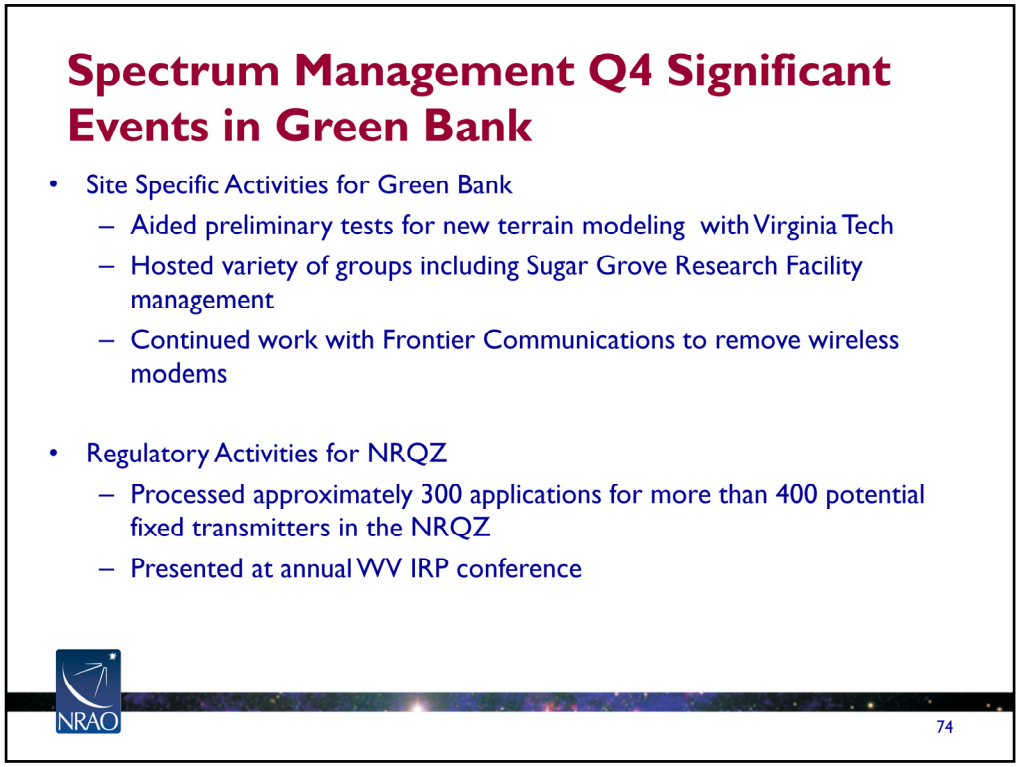


Regulatory Activities – 1) NRAO filed reply comments with FCC responding to a request from Toyota which would greatly increase the emitted power levels of 76 GHz vehicular radars. These radars could burn out a receiver if directed toward a radio astronomy antenna at close range. The issue has implications for ALMA because Chile typically follows the practices which are adopted elsewhere. 2) NRAO wrote to HughesNet reminding them of their ongoing obligation under FCC rules to notify NRAO of satellite broadband installations within the Quiet Zone. Hughes and other vendors have generally ignored this obligation.

International Activities – 1) The spectrum manager attended a CORF meeting in Santiago in August and discussed various compatibility and interference issues with the ALMA project, which generally has been very slow to recognize the importance of preserving the electromagnetic environment. 2)At a long series of meetings in Geneva in September, an NRAO-generated report was approved for ITU-R publication, noting the input power levels which suffice to damage HEMT and SiS receivers. This information is necessary background material for coordination with many spectrum users; a new coordination agreement between radio astronomy and high-power space-borne radars is in progress with representatives of the Space Frequency Coordination Group. 3) Work progressed on a WRC12 agenda item seeking to update recognition of use of (unallocated) spectrum at 275 – 3000 GHz by passive services. 4) Many compatibility issues were addressed, especially the interference generated by use of power lines for broadband connections and impending proliferation of so-called cognitive radios which opportunistically seek to take advantage of "unused" spectrum. 5) The NRAO spectrum manager formally became a member of IUCAF at the IAU GA in Rio.

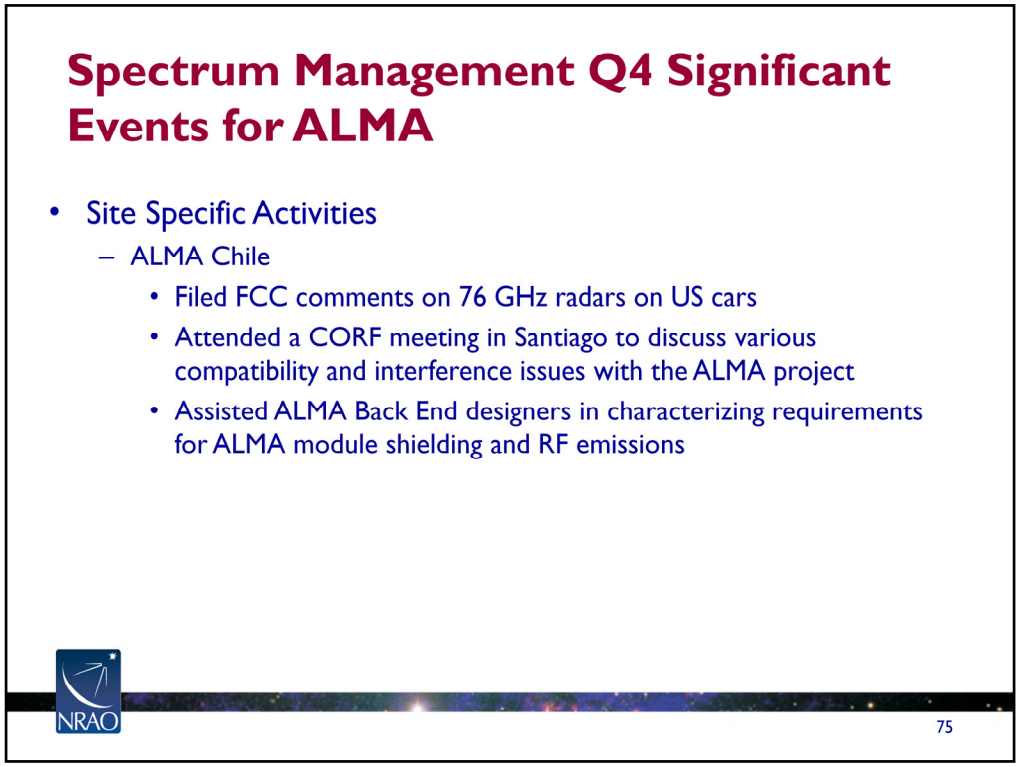
Spectrum Management Q4: Significant Activities in New Mexico

- Site Specific Activities:
  - Re-surveyed the VHF and UHF Radio Frequency (RF) environment at the EVLA site in order to assess the impact of the change-over to digital TV in June 2009
  - Measured and characterized RF emissions from a number of local area network (LAN) devices, personal computer monitors, and video projectors as a prelude to EVLA site VHF spectrum "clean-up"
  - Reviewed the EVLA site L-band environment in order to provide a list of suitable target emitters for EVLA correlator testing
  - Performed a high-sensitivity survey of the 1612 MHz OH RF environment and provided results (showing GLONASS and IRIDIUM satellite channel re-allocations) to the international radio astronomy community
  - Assisted ALMA Back End designers in characterizing requirements for ALMA module shielding and RF emissions



Worked with Virginia Tech on testing the ideas behind a new **terrain modeling** program for propagation studies. If this is successful, further studies will be done. Hosted groups from **sugar grove** (management and new staff), quarter century wireless association. The RFI Group located 13more local telephone company wireless modems and is working on having these removed by **Frontier Communications**, Co. Spectrum plots where updated and archived. A wide variety of electronic gear was characterized in the anechoic chamber.

Applications processed including new transmitter requests as well as requests for changes due to, e.g. narrow banding of the power spectrum transmitted. Annual **WV Interoperability (IRP) Conference** is a gathering of all folks involved in state and regional 9-1-1 communications; Gave a talk and had a booth at the conference.



Filed **FCC comments responding to Toyota's petition to allow higher power 76 GHz radars on US motor vehicles** (which has long-range implications for spectrum management in Chile).

Spectrum manager attended **a CORF meeting** in Santiago to discuss various compatibility and interference issues with the ALMA project, which generally has been very slow to recognize the importance of preserving the electromagnetic environment. Spectrum Management also assisted **ALMA Back End designers** in characterizing requirements for ALMA module shielding and RF emissions.

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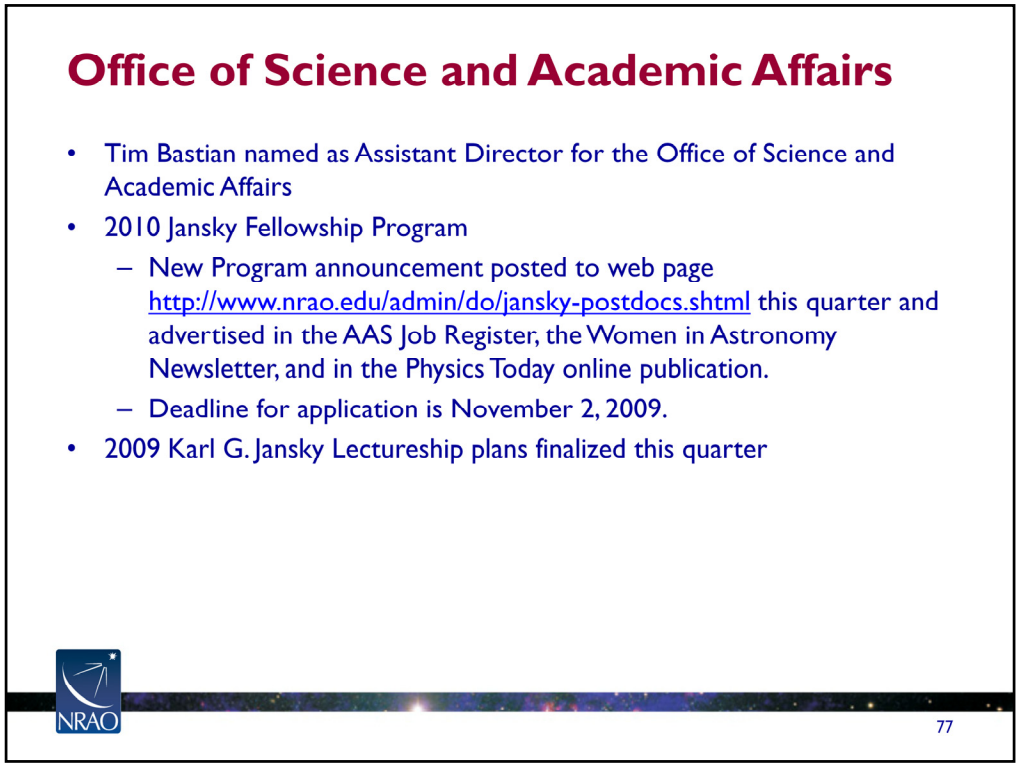
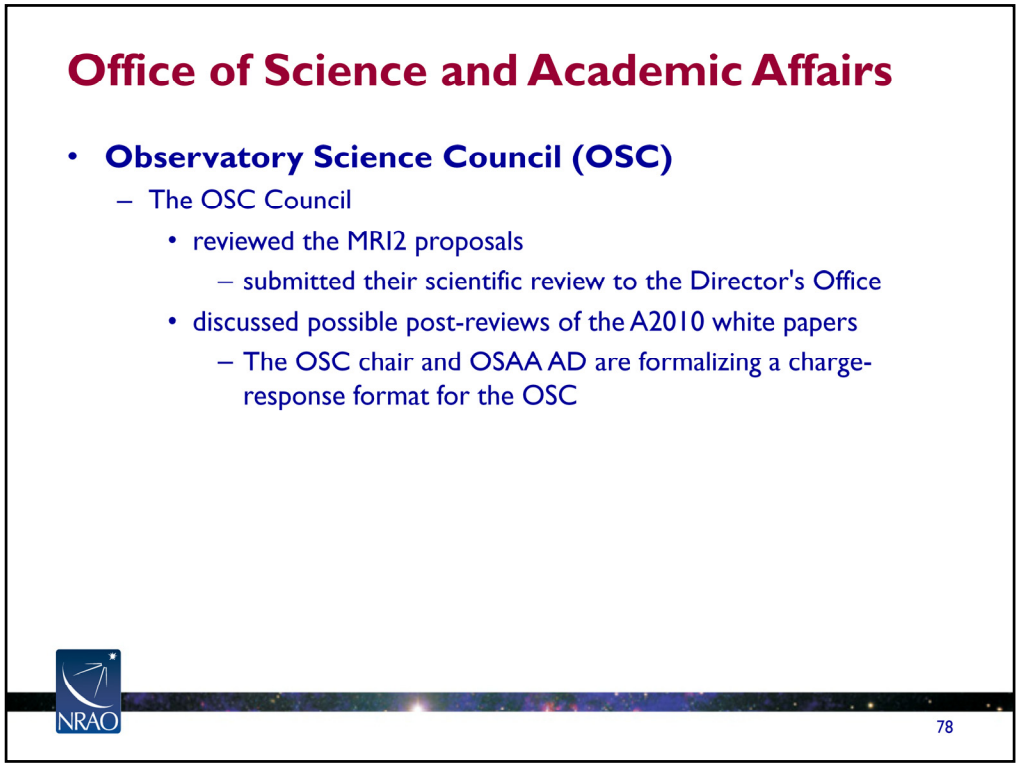


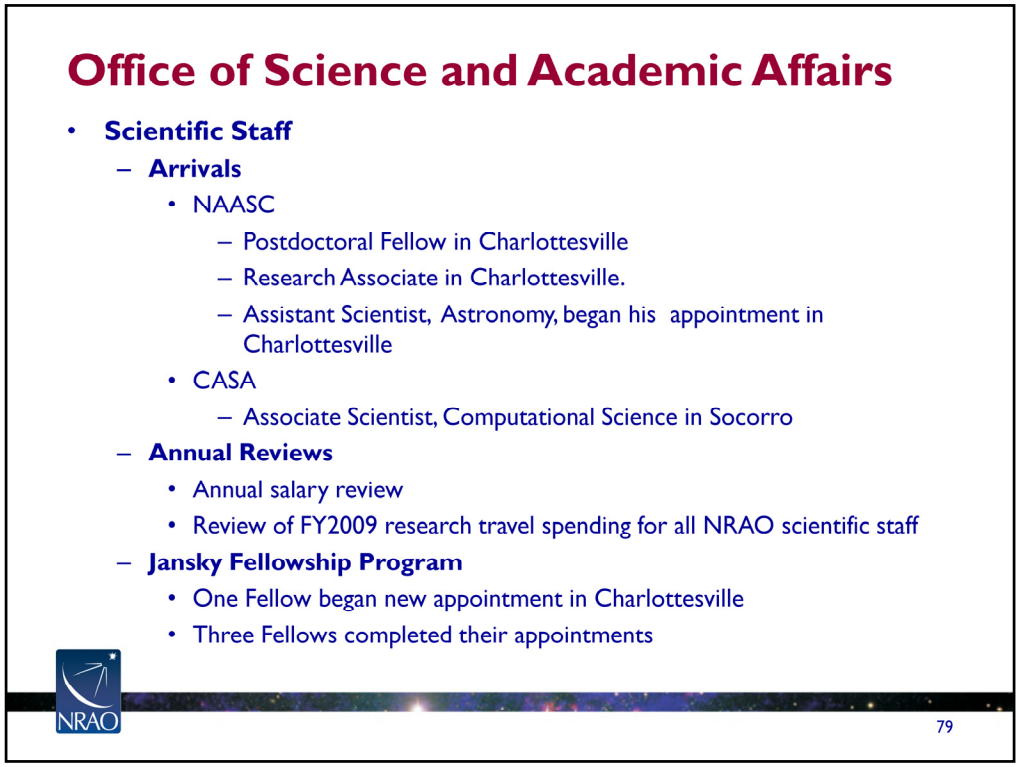
Tim Bastian named as Assistant Director for the **Office of Science and Academic Affairs**, replacing Dale Frail, who completed his three-year term as Assistant Director in July.

A new Program announcement for the **2010 Jansky Fellowship Program** was posted to the web page http://www.nrao.edu/admin/do/jansky-postdocs.shtml this quarter and advertised in the AAS Job Register, the Women in Astronomy Newsletter, and in the Physics Today online publication. The deadline for application is November 2, 2009.

2009 **Karl G. Jansky Lectureship** plans finalized this quarter. To be presented in Charlottesville on October 27 and in Socorro on January 15 by Anthony C. S. Readhead, Director of the Owens Valley Radio Observatory, Caltech. The Lecture is entitled, The Central Engines that Power Active Galaxies. Details available online at http://www.nrao.edu/jansky/2009/readhead.shtml.



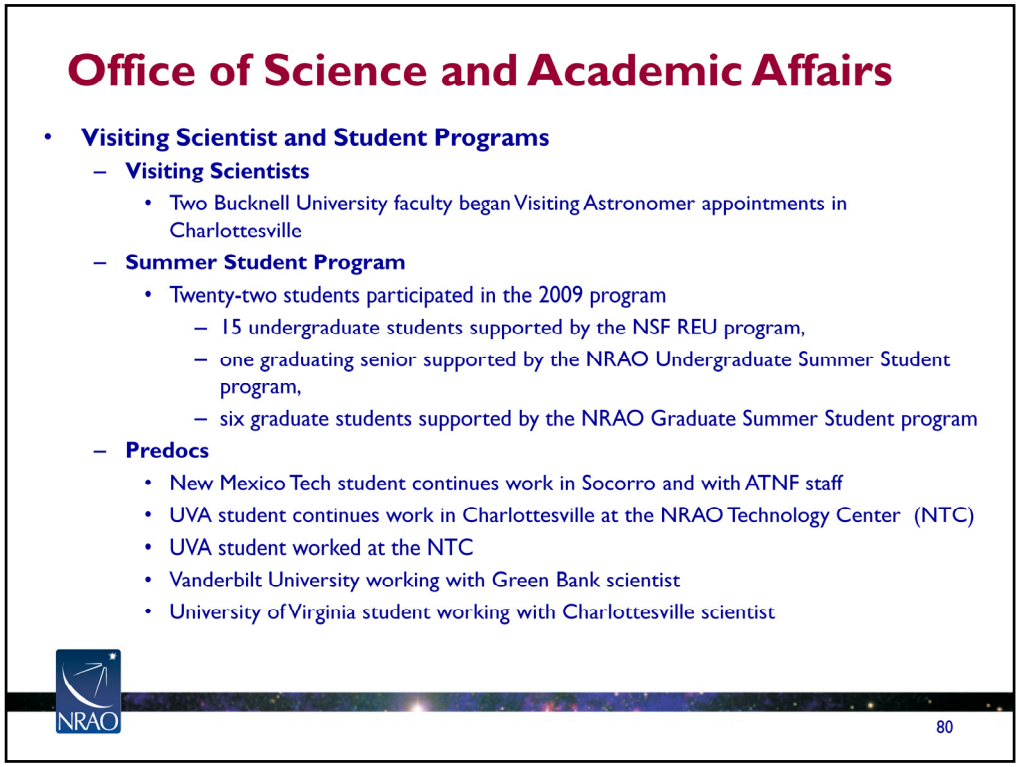
The Council **reviewed the MRI2** proposals, and submitted their scientific review to the Director's Office. They also met and discussed possible post-reviews of the **A2010 white papers**. The OSC chair and OSAA AD are formalizing a **charge-response format** for the OSC.



Arrivals to the Scientific Staff included: Postdoctoral Fellow began work in Charlottesville with the NAASC. Research Associate began working with Carol Lonsdale, and the NAASC, in Charlottesville. Assistant Scientist, Astronomy, began his appointment in Charlottesville working with the NAASC. Associate Scientist, Computational Science began working with CASA in Socorro.

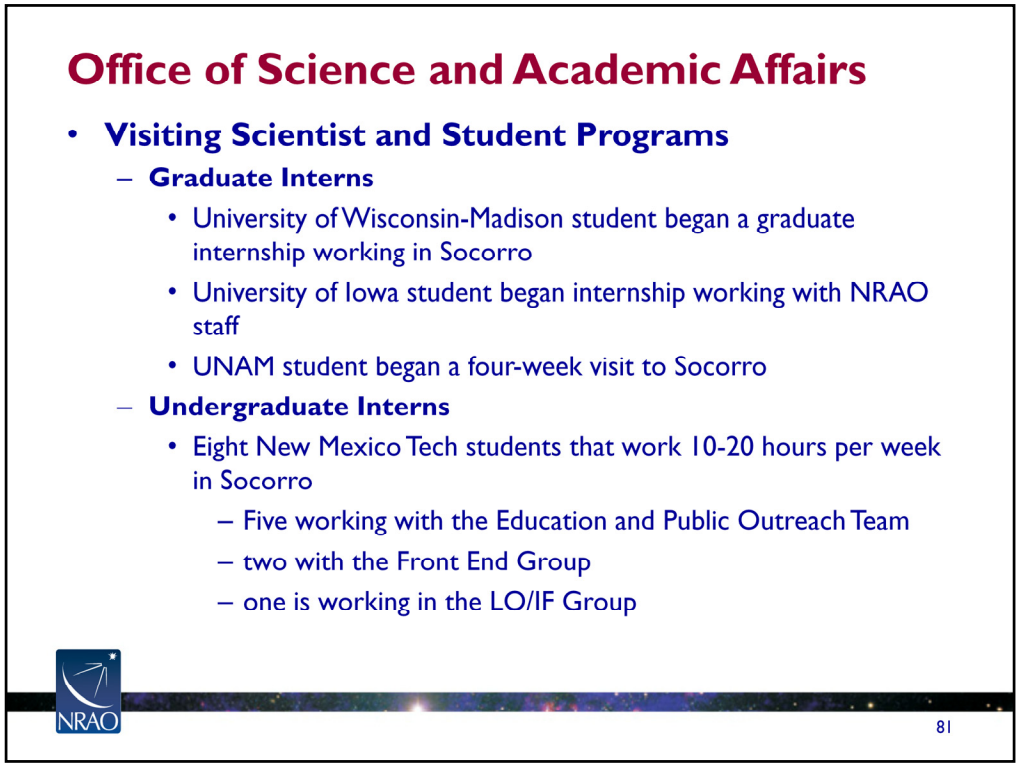
In addition to the **annual salary review**, the OSAA conducted a review of FY2009 **research travel spending** for all NRAO scientific staff. Individual budget allocations for FY2010 will be distributed in October.

One **Jansky Fellow** began new appointment in Charlottesville this quarter. **Three Fellows** completed their appointments, heading for the Submillimeter Array at the Center for Astrophysics at Harvard, a Hubble Fellowship with the University of Chicago, and the University of Illinois.

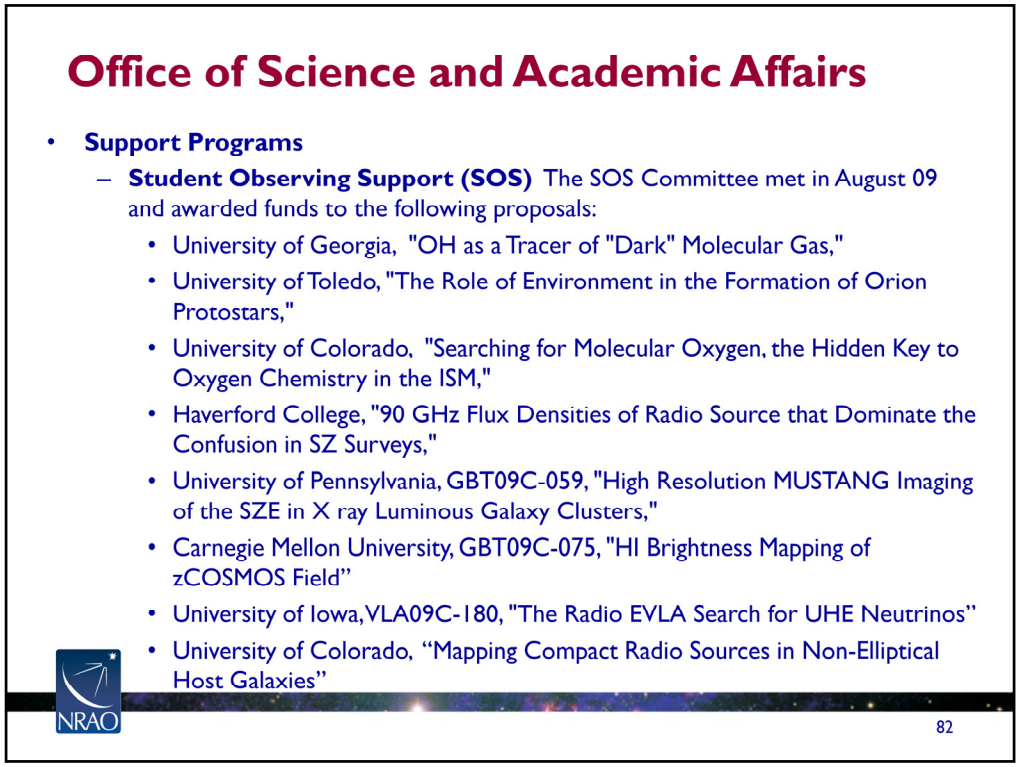


Two **Bucknell University** faculty began Visiting Astronomer appointments in Charlottesville working with the NAASC while on one year sabbaticals from home institution. Twenty-two students participated in the **2009 Summer Student program**, including 15 undergraduate students supported by the NSF REU program, one graduating senior supported by the NRAO Undergraduate Summer Student program, and six graduate students supported by the NRAO Graduate Summer Student program. This was the 50th year of the NRAO Summer Research Program, which has graduated more than one thousand students in its tenure.

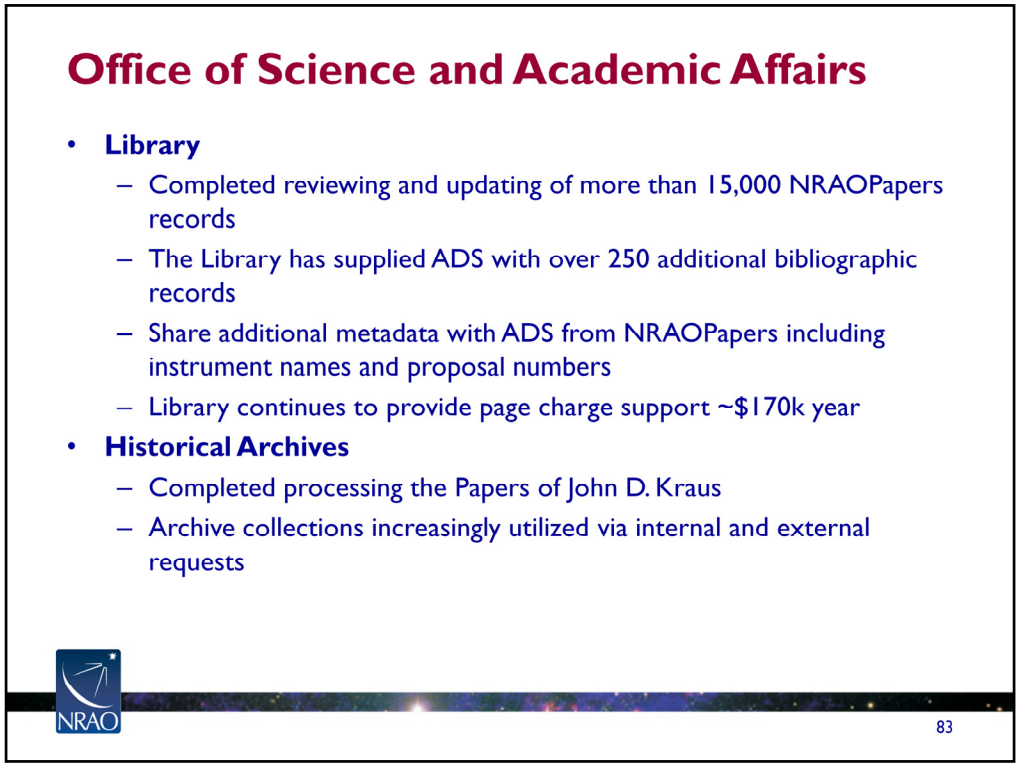
Predocs include: **New Mexico Tech** student continues work in Socorro and with ATNF staff investigating parameterized deconvolution in radio synthesis imaging, specifically for high-dynamic-range and multi-frequency imaging with the EVLA. **UVA student** continues work in Charlottesville at the NRAO Technology Center (NTC) on instrumentation for low-frequency radio astronomy arrays. **UVA student** worked at the NTC on development and fabrication of ultra-wide-band feeds for a variety of radio astronomy applications. **Vanderbilt University** continues working with Green Bank scientist on HI observations of interacting galaxies with the GBT and VLA. **UVA student** working with Charlottesville scientist on reducing and analyzing VLBI observations of water maser emission from galactic nuclei as part of the Megamaser Cosmology Project.



University of Wisconsin-Madison student began a **graduate internship** working in Socorro with an NRAO staff member on a project toward his thesis, entitled "The MicroJy Radio Population in the A370 Cluster Field." **University of Iowa** student began internship working with NRAO staff on PhD thesis project, "High Sensitivity Time-Lapse Radio Imaging of Stellar Magnetospheres." **UNAM student** began a four-week visit to Socorro to conduct research projects related to distance and proper motion determinations of young stars toward his PhD thesis with NRAO staff member. The **Undergraduate Intern Program** presently includes eight New Mexico Tech students that work 10-20 hours per week in Socorro. Five are working with the Education and Public Outreach Team, two are with the Front End Group, and one is working in the LO/IF Group.



The Student Observing Support (SOS) Committee met in August 09 and awarded funds to the following proposals: **University of Georgia**, GBT09C-006, "OH as a Tracer of "Dark" Molecular Gas," $14,897; **University of Toledo**, GBT09C-040, "The Role of Environment in the Formation of Orion Protostars," $27,237; University of Colorado, GBT09C-046, "Searching for Molecular Oxygen, the Hidden Key to Oxygen Chemistry in the ISM," $1,500; **Haverford College**, GBT09C-050, "90 GHz Flux Densities of Radio Source that Dominate the Confusion in SZ Surveys," $1,463; **University of Pennsylvania**, GBT09C-059, "High Resolution MUSTANG Imaging of the SZE in X ray Luminous Galaxy Clusters," $18,000; **Carnegie Mellon University**, GBT09C-075, "HI Brightness Mapping of zCOSMOS Field,, $17,500; **University of Iowa**, VLA09C-180, "The Radio EVLA Search for UHE Neutrinos," $19,500; **University of Colorado**, VLBA09C-130, "Mapping Compact Radio Sources in Non-Elliptical Host Galaxies," $18,412.70.



Completed reviewing and updating of more than 15,000 NRAOPapers records with ADS BibCodes and additional metadata. The **Library** has supplied ADS with over 250 additional bibliographic records this quarter. Continue work with ADS to share additional metadata from NRAOPapers including instrument names and proposal numbers.

Historical Archives completed processing the Papers of **John D. Kraus**, work that was begun with initial indexing in 2006. Final arrangement, description, indexing, foldering, and boxing of the material was begun in February 07 and completed in August 09. Processing Director's Office materials and Bracewell materials continues. Employed a UVA student for a month to scan correspondence and reports from the period 1954-1960 related to NRAO's founding and very early organization, as well as a selection of VLA construction slides. Archive collections increasingly utilized via internal and external requests.

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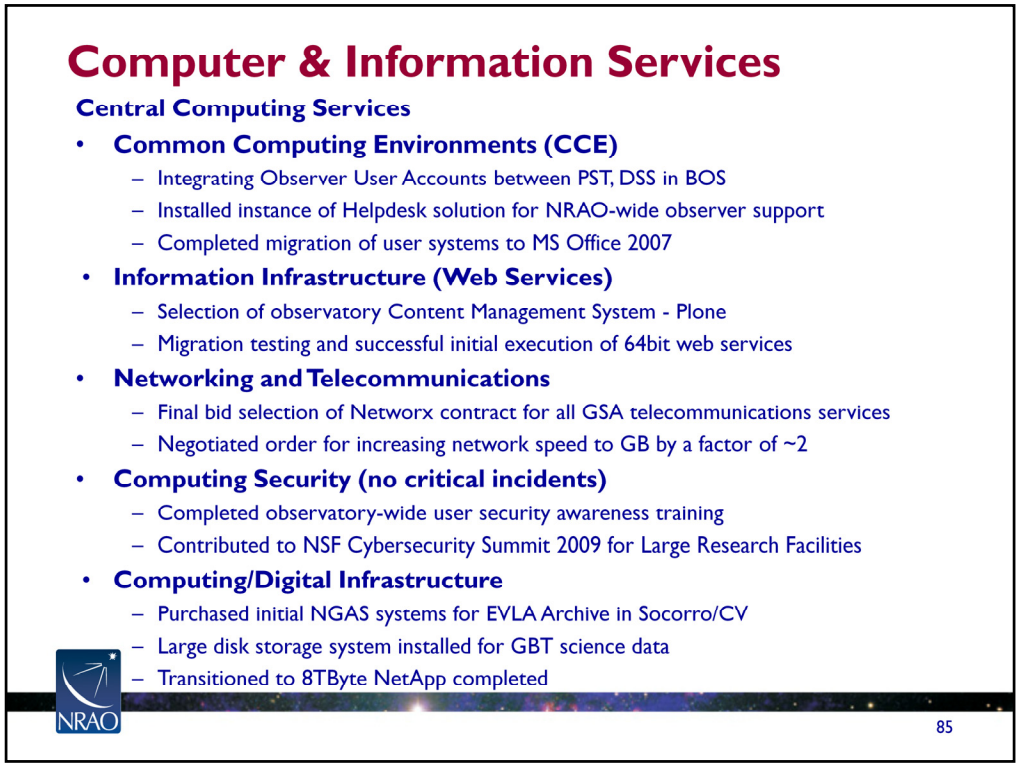

Common Computing Environments (CCE): Extensive work to integrate **Observer User Accounts** between PST, DSS in BOS; Installed instance of **Helpdesk** solution for NRAO-wide observer support; Completed migration of user systems to **MS Office 2007** and upgrade to MS Office 97**.** No critical outages (Observation Impact) occurred in this quarter. Average service availability was in excess of 99.9%.

Information Infrastructure (Web Services): Executed Content Management System review with selection of **Plone** (in alignment with ESO/ALMA) and selected it as the Observatory's Content Management System. Migration testing and successful initial execution of **64bit web services.** Successfully completed external facing **web server upgrades to 64bit OS** without incident.

Networking and Telecommunications: Final bid selection of **Networx contract** for all GSA telecommunications services. Negotiated order for increasing **network speed to GB** by a factor of ~2 at reduced cost. Full circuit inventory for all GSA FTS2000 contract communication services validated and bid to five primary vendors under Networx. The upgrade circuit order for the Green Bank WAN link to DS3 (45Mbps) speeds was placed with scheduled go-live of October 2009. ARRA funding request for Gigabit link underway in conjunction with WVU.

Computing Security (no critical incidents): Completed Observatory-wide user cyber security and data sensitivity training **security awareness training**. Contributed to **NSF Cybersecurity Summit 2009** for Large Research Facilities. Compromised external accounts, insecure web applications and wiki plug-in caused some emergency upgrades following two unauthorized access events to user accounts during this quarter.

Computing/Digital Infrastructure: Purchased initial eight **NGAS systems** for Science Data Archive in Socorro/CV to support EVLA (~80TBytes). **250 TB of disk storage ordered in GB** to support storage of GBT observation data; **large disk storage system** installed for GBT science data (250TBytes). Transitioned to 8TByte NetApp completed and **8 TeraBytes of high availability disk storage** for Green Bank went live in July. Addressed a pain point for Observers requesting time on the NRAO instruments by **alignment of observer account schemes** for the Proposal Submission Tool, GBT Dynamic Scheduler and BOS visitor support systems.

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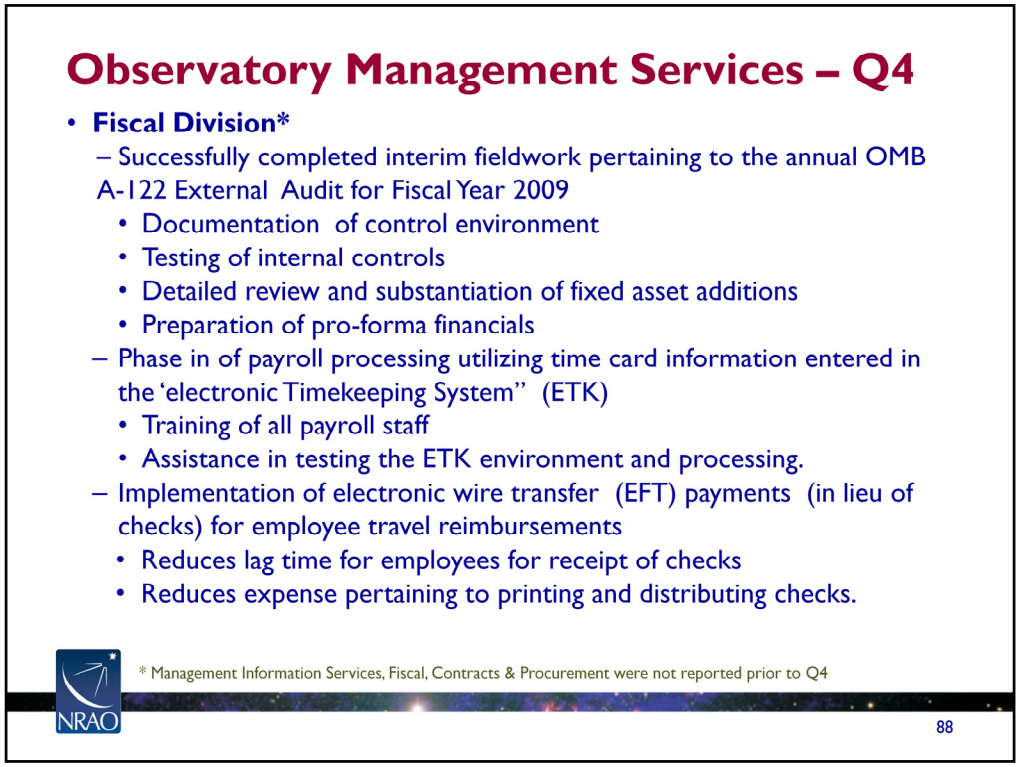
  - Observatory Management Services

Observatory Management Services

- **Management Information Services (MIS) * - Q4**
  - Go-Live of Electronic Time Keeping (ETK) to NRAO Staff
  - Transition of NRAO Payroll from paper timesheets to ETK
  - External Audit for IT systems
  - Design of Chart of Accounts/Reporting for New Cooperative Agreement

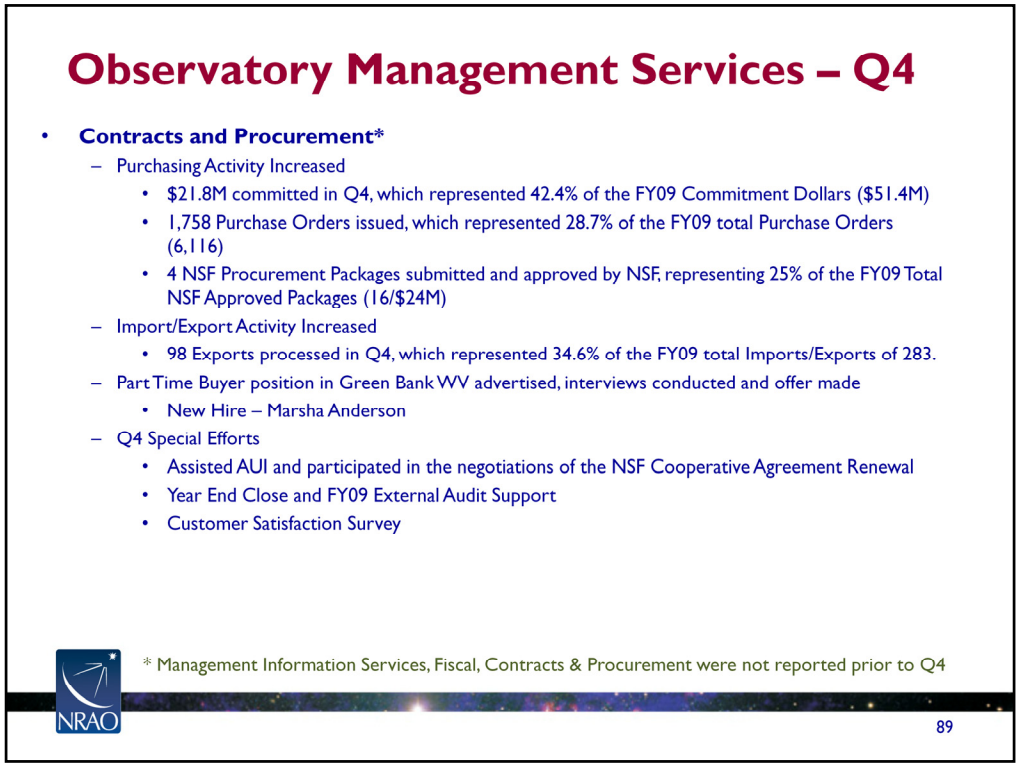
* Management Information Services, Fiscal, Contracts & Procurement were not reported prior to Q4



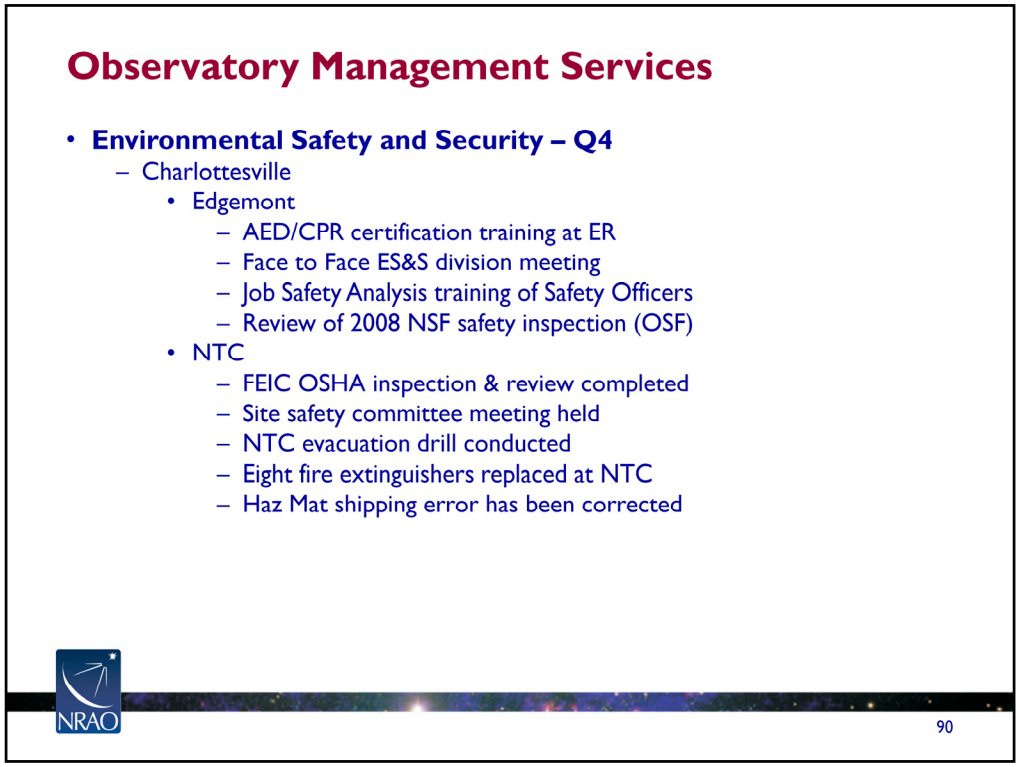
Successfully completed interim fieldwork pertaining to the annual OMB A-122 External Audit for Fiscal Year 2009. Interim fieldwork included the following: **documentation of control environment** pertaining to all processes administered by the Fiscal Department; **testing** of internal controls to achieve reliance for substantive test work, substantive test work pertaining to compliance with OMB A-133 requirements for the period 10/01/08 through 06/30/09 expenditures; detailed review and substantiation of **fixed asset** additions; preparation of pro-forma financials to be utilized for FY 09 reporting.

Phase in of payroll processing utilizing time card information entered in the 'electronic Timekeeping System" (ETK) The phase in required: **training** of all payroll staff regarding payroll process changes, assistance of the payroll staff in developing required reports to assist with payroll review, and assistance in **testing the ETK** environment and processing.

Implementation of **electronic wire transfer** (EFT) payments (in lieu of checks) for employee travel reimbursements. Implemented successfully for employees located at the Green Bank and Charlottesville sites. Reduces lag time for employees for receipt of checks. Reduces expense pertaining to printing and distributing checks.



Purchasing Activity – There were several large awards made during the 4th Quarter for the AOS Formation Level Road Construction ($5.2M) and the AOS Electrical Utilities Infrastructure Construction ($9.8M)



Edgement Rd conducted in-house **AED training** as well as Job Safety Analysis (JSA) training for the Observatory's Safety Officers in September. Routine building maintenance activity conducted by UVA Facilities at ER included fire main & sprinkler system maintenance, as well as landscape trimming for security purposes. NTC completed its **FEIC** (Front End Integration Center) OSHA inspection (internal) in August. ALMA system safety reviews continue on schedule. ALMA conducted all routine safety committee meetings and evacuation drills on time. The facility's **fire extinguishers** were inspected and 8 were replaced. A face to face meeting of the Executive Safety Managers was held in Chile where the 2008 NSF safety review defects and actions list was reviewed. The report to be delivered to ALMA Board in October. Additional training conducted at ER included JSA (train the trainer) for the facility Safety Officers. NTC has completed its review of a Hazardous Material paperwork shipping error (corrected).

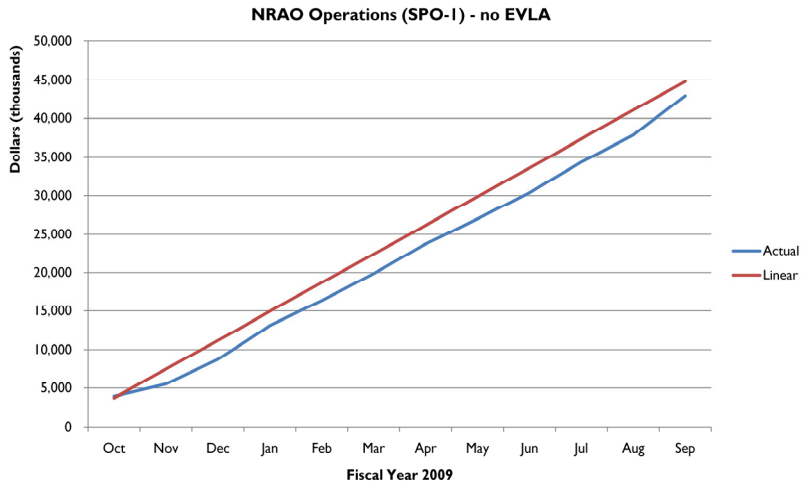
Observatory Management Services

- **Environmental Safety and Security – Q4**
  - **New Mexico**
    - Monthly VLA Site Safety Meetings all conducted
    - Tech Building Safety Inspection and Evac Drill for Tech Services Bldg completed at VLA
    - O&M Plan for PTSD (Petroleum Storage) submitted (final edits)
    - EVLA Correlator room FM 200 Fire Suppression system Inspected & Tested
    - Security Upgrades begun at VLBA (Hancock)
    - Kitt Peak VLBA ES&S Inspection accomplished
    - AOC West Safety Inspection Conducted
    - State approved Wildlife Management Activity concluded at VLA

Observatory Management Services

- **Environmental Safety and Security – Q4**
  - **Green Bank**
    - GB inspected site fire sprinklers (annual)
    - Sewer treatment system continues in compliance
    - Annual Respirator refresher training
    - Confined space training (annual)
    - Site-wide OSHA compliance inspection (internal)
    - Site safety committee meeting conducted (quarterly)

Observatory Management Services Financial Performance



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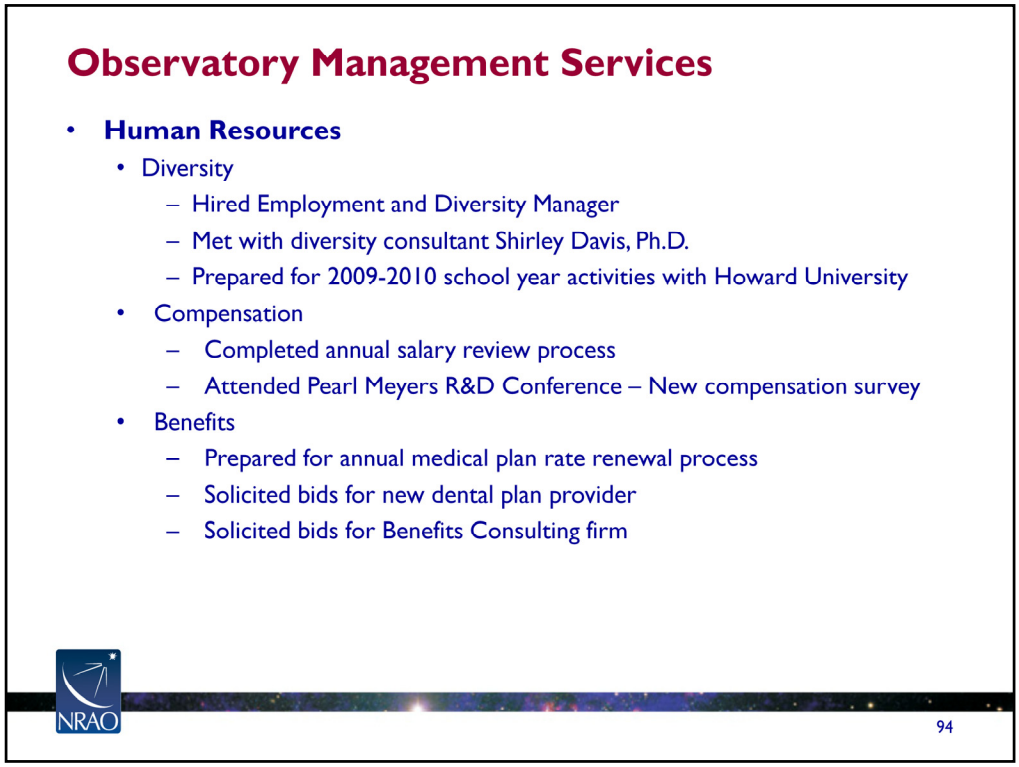
FY 2009 projected budget expenditures were $44.8M versus a $42.9M actual. The difference in expenditures were primarily due to delayed hires and turnover in the Salaries & Benefits line for SAA/NM Operations and Green Bank Operations. The unspent funds will be used to help offset funding shortfalls projected in FY 2012-2014 timeframe.



Faye Giles joined NRAO in July as NRAO's **Employment and Diversity Manager**. Her role is new to NRAO, marking the formal establishment of a dedicated diversity manager in the Observatory. Her first major task was to find a **diversity consultant** to assist NRAO in developing and executing a diversity action plan that supports the NRAO Diversity Plan and the AUI Broadening Participation Action Plan. She identified Shirley Davis, Ph.D., Director of Diversity Initiatives for the Society for Human Resource Management as the best consultant. An introductory meeting was held in September, which resulted in NRAO requesting a consulting proposal. Ms. Giles also conducted internal meetings to prepare for NRAO diversity support for **Howard University** during the 2009-2010 school year.

Shirley Franks, Senior Compensation Analyst, led the **annual salary review** process that began in July and ended in September. She then attended the Pearl Meyer & Partners annual Research and Development Survey Conference in September. The **Research and Development Survey** is a combination maturity curve and benchmark survey conducted annually. The survey covers cash compensation - base salaries and bonuses - for Scientists and Engineers. This is the first year of NRAO participation in the survey and marks the final key step in completing the exempt staff market pricing project.

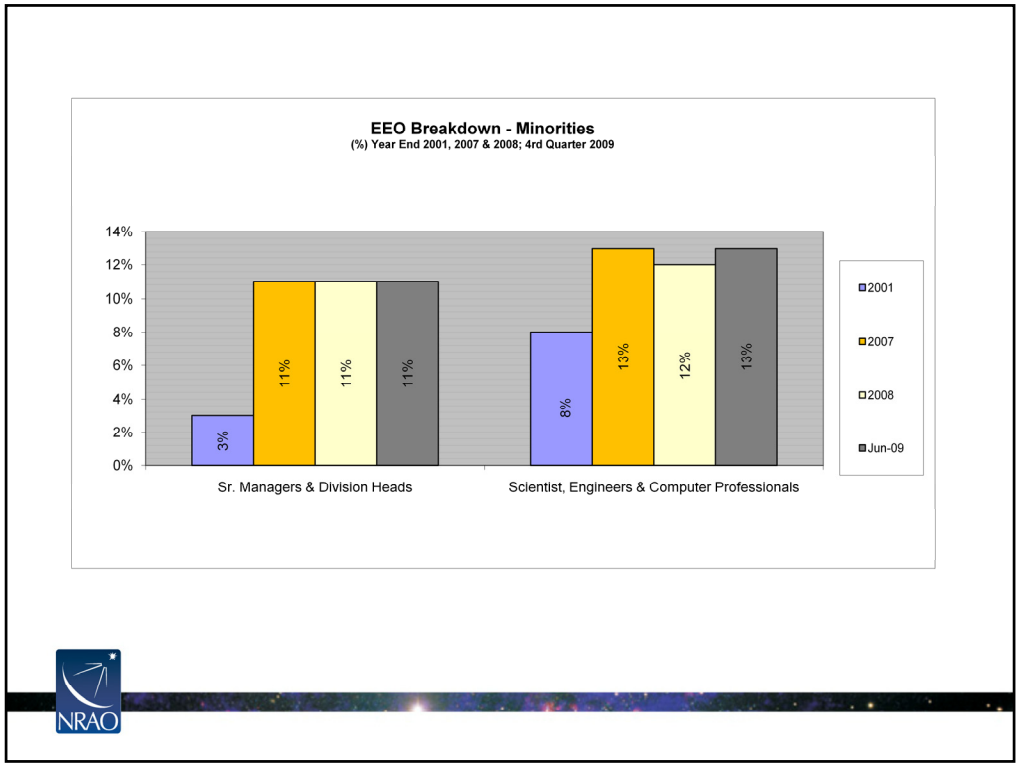
Denise Utley, Benefits Analyst, led the **annual medical plan rate renewal process** with Cigna, through NRAO's benefits consulting firm Aon Consulting. Included in the renewal timeframe is the development and **solicitation of bids** for a new dental plan provider. The final decision meetings will be conducted in October. She also developed and distributed separate RFPs for NRAO's dental plan and its benefits consultant.

Observatory Management Services

- **Human Resources**
  - Diversity Employment Results

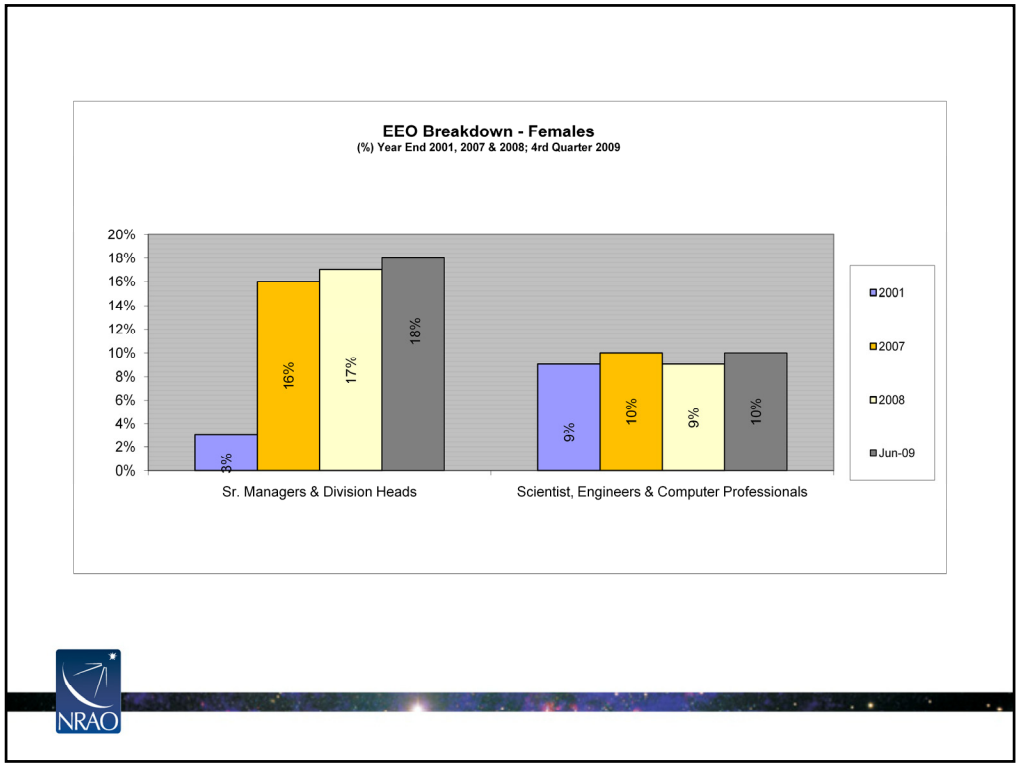
    New Hires –

    Administrative (Manager) – 1 Female , African American [CV]
    Administrative – Female [1 CV; 1 GB; 1 VLA]
    Scientific, Research Associate – 1 Male, Asian [CV]
    Scientific, Post Doc – 1 Female [CV]
    Scientific, Jansky Fellow – 1 Male, Hispanic [SOC]



The following Affirmative Action information reflects the continued minority diversification efforts of the Observatory in the science and professional/technical workforce.

The Observatory continues to sustain its progress in hiring and retaining minorities in two key groups: Sr. Managers & Division Heads; and Scientific, Engineers and Computer Professionals. One female minority was added to the Scientific Staff in the 4rd Qtr FY09.



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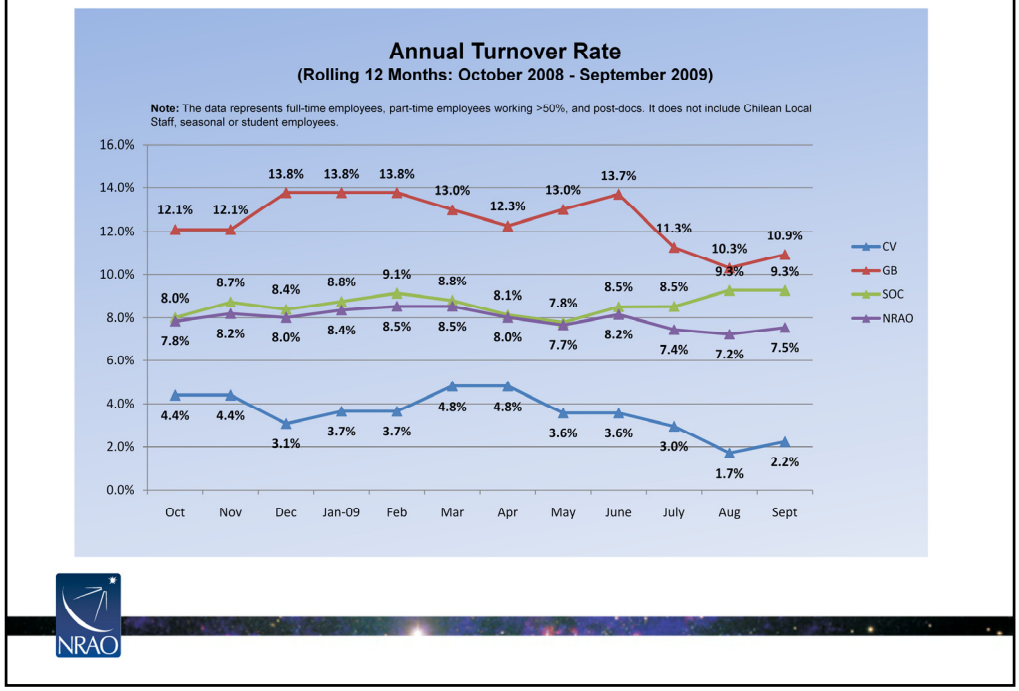

The NRAO turnover decreased by 0.7% in Q4 FY09. Both Charlottesville and Green Bank experienced decreases in attrition of 1.4% and 2.8%, respectively. Socorro attrition increased by .8%, raising the annualized rate to 9.3% (it's highest) and requiring us to closely monitor this trend over the next quarter.