

EVLA Status and Prospects

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



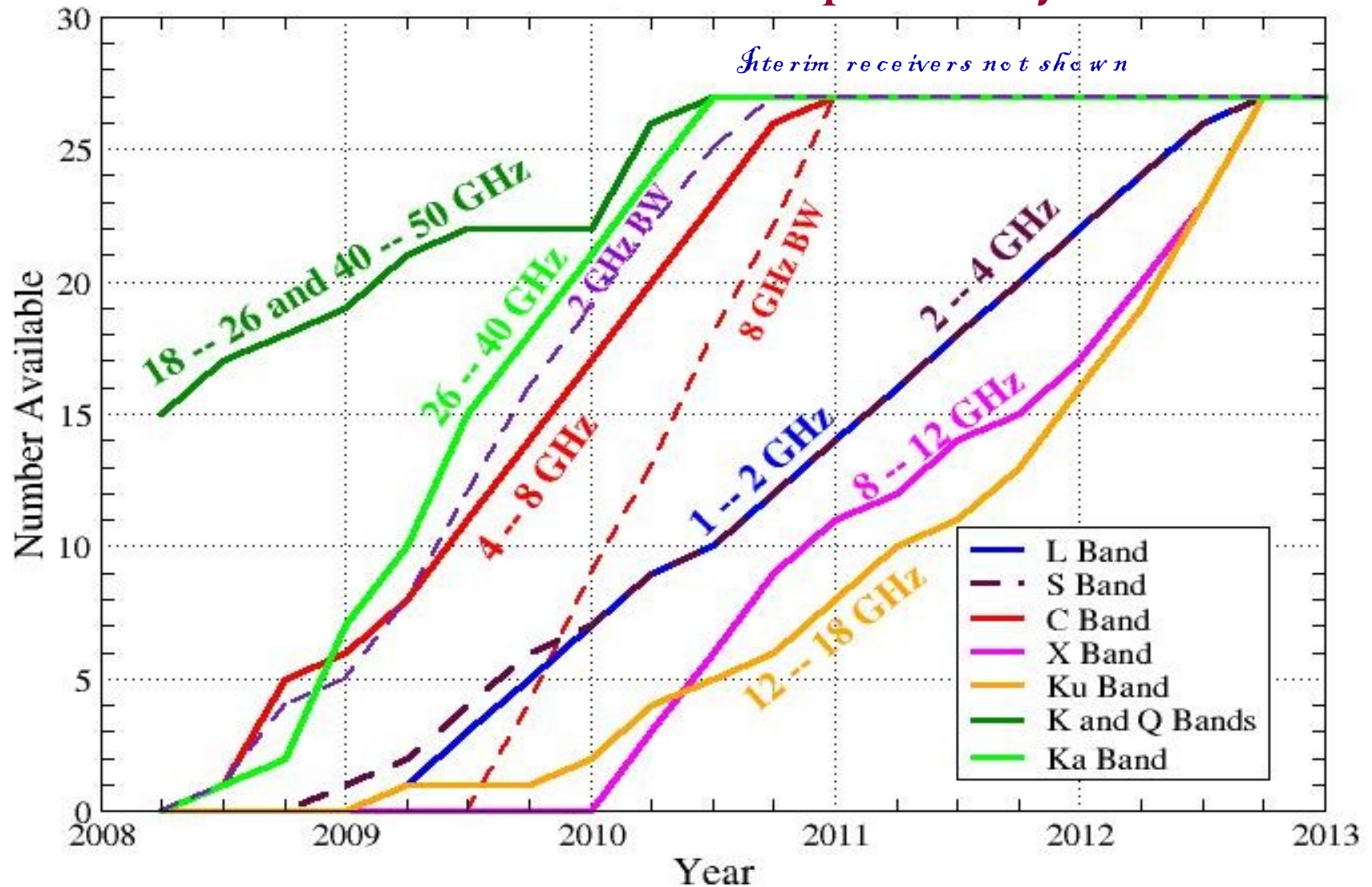
Summary

- *Project is going well*
- *Financial health of the project is good*
- *Technical issues largely resolved*
- *Project is on schedule:*
 - *Antenna retrofits will be complete in Q4 2010*
 - *Receiver installation complete in Q4 2012*
 - *Correlator scheduled for completion in Q4 2010*
 - *Software development on track to support commissioning and early science*

Current status

- All fiber laid
- **21 EVLA antennas** now in use -- account for >70% of ant-hours
- All feed horns fabricated for L, C, Ka; S and Ku underway
- **10 Ka-band, 2 S-band receivers** deployed
 - L-band prod'n begins 2009
 - Ku-band prototype under development
- **OMTs meet specifications** (L, C, S); X-band design nearly done
- LO/IF ahead of schedule
- 8-bit (1 GHz) samplers installed; first 3-bit (2 GHz) due in June
- Real-time **software on track** (migrated from Modcomps; Proposal, ObsPrep, Scheduler, Archive Tools; WIDAR systems integration)
- Post-processing software looking good (CASA; algorithms; cluster)
- WIDAR correlator
 - data cables & all racks installed
 - final hardware ordered
 - 10-station, 4 subband, single pol'n **WIDAR-0 fringing nicely** (March 6)

Schedule: Growth of New Capability



Using the EVLA: OSRO, RSRO, & you

Open Shared Risk Observing (OSRO)

- <http://www.aoc.nrao.edu/evla/astro/osro.shtml>
- *Ti 2010 (1 octog proposal deadline):*
 - *Nw bands*
 - $2 \times 128 / 2^N$ ~~Mk~~ full pol'n 64 channels; or
 - $1 \times 256 / 2^N$ ~~Mk~~ dual pol'n, 256 channels
 - *1 sec dumps*

WIDAR Operational;

VLA Correlator

Turned Off



Construction

Completed



Year	2010				2011				2012				2013				2014	
Config.	D	D	C	B	A	D	C	B	A	D	C	B	A	D	C	B	A	
BW	256 MHz ⇒				2 GHz ⇒				8 GHz ⇒				...(recirc., sp. modes)					

Resident Shared Risk Observing (RSRO)

- <http://www.aoc.nrao.edu/evla/astro/rsro.shtml>
- Experts in residence as temporary staff members in exchange for early access
 - up to 100 hrs/month
 - NRAO staff also have early access
- Scientific, technical, & budgetary review
- Regular proposal calls, starting 1 October 2009
- Rough schedule:
 - T1 2010: 2x1 GHz total BW, 0.1 sec dumps
 - T2 2010: 2x8 GHz total BW
 - T3 2010: Recirculation (lots more channels)
 - T1-T2 2011: Increased flexibility in correlator resource allocation
 - T3 2011-: Special modes (pulsars, speed dumps, ...)

Tables & useful details

SEFD & sensitivity results

	Band (GHz)	SEFD/Jy		Sensitivity/1σ, 9hrs	
		Req'd	Actual#	Full BW μJy	1 km/s mJy
L	1 – 2	325	TBD	1.6	0.5
S	2 – 4	235	~280*	~1.0*	~0.6*
C	4 – 8	260	275	0.7	0.3
X	8 -- 12	300	TBD	0.8	0.3
Ku	12 -- 18	385	TBD	0.8	0.3
K	18 -- 26.5	650	420	0.75	0.25
Ka	26.5 -- 40	760	600	1.1	0.29
Q	40 -- 50	1570	1310	2.3	0.76

Blue = System tested

Red = Prototypes to be tested in 2009

* Preliminary result

Rough average over the band

$$\text{SEFD} = 5.62 T_{\text{sys}}/\epsilon$$

$$\sigma = \text{SEFD}/[\eta_c N_A \sqrt{B\tau}]$$

$$\eta_c = 0.91 \text{ (4-bit)}$$

$$N_A = 27$$

OSRO WIDAR modes (1)

- Continuum applications and spectro-polarimetry
 - Two independently-tunable sub-band pairs (IFs), full pol., each with bandwidth $128/2^n$ MHz ($n=0,\dots,12$), 64 channels

Sub-band BW (MHz)	Number of poln. products	Number of channels/poln product	Channel width (kHz)	Channel width (kms ⁻¹ at 1 GHz)	Total velocity coverage (kms ⁻¹ at 1 GHz)
128	4	64	2000	$600/v(\text{GHz})$	$38,400/v(\text{GHz})$
64	4	64	1000	300	19,200
32	4	64	500	150	9,600
16	4	64	250	75	4,800
8	4	64	125	37.5	2,400
4	4	64	62.5	19	1,200
2	4	64	31.25	9.4	600
1	4	64	15.625	4.7	300
0.5	4	64	7.813	2.3	150
0.25	4	64	3.906	1.2	75
0.125	4	64	1.953	0.59	37.5
0.0625	4	64	0.977	0.29	18.75
0.03125	4	64	0.488	0.15	9.375

OSRO WIDAR modes (2)

- Spectral line applications
 - One tunable sub-band pair (IF), dual polarization, with bandwidth $128/2^n$ MHz ($n=0,\dots,12$), 256 channels

Sub-band BW (MHz)	Number of poln. products	Number of channels/poln product	Channel width (kHz)	Channel width (kms ⁻¹ at 1 GHz)	Total velocity coverage (kms ⁻¹ at 1 GHz)
128	2	256	500	$150/v(\text{GHz})$	$38,400/v(\text{GHz})$
64	2	256	250	75	19,200
32	2	256	125	37.5	9,600
16	2	256	62.5	19	4,800
8	2	256	31.25	9.4	2,400
4	2	256	15.625	4.7	1,200
2	2	256	7.813	2.3	600
1	2	256	3.906	1.2	300
0.5	2	256	1.953	0.59	150
0.25	2	256	0.977	0.29	75
0.125	2	256	0.488	0.15	37.5
0.0625	2	256	0.244	0.073	18.75
0.03125	2	256	0.122	0.037	9.375

RS RO: T1 2010-T2 2011

Date	Array Config	Total bandwidth per pol'n	Number of subband pairs	Channels per sb pair (4 pp)	Comments
T1 2010	D	1 GHz	16	64	All sb identical 8-bit samplers
T2 2010	C	8 GHz	64	64	All sb identical 3-bit samplers
T3 2010	B	8 GHz	64	$\leq 16,384$	All sb identical Add recirculation
T1 2011	A	8 GHz	64	$\leq 16,384$	Independent subbands
T2 2011	D	8 GHz	64	$\leq 16,384$	Can trade subbands for channels

Potential Areas of RSRO Participation

- **Development of correlator modes**
 - General correlator resource allocation
 - Multiple spectral lines for Galactic and extragalactic applications
 - Solar observing
 - Planetary observing
 - Astrometry
 - Phased array and VLBI
 - Pulsars
- **Development of observing and calibration strategies**
 - Wideband calibration methods
 - High frequency calibration
 - Improved referenced pointing
 - Ionospheric calibration
 - Calibrator models
 - Polarimetry
 - Mosaicing
 - RFI excision
- **Development of data red'n strategies & algorithms**
 - Automated flagging
 - Wideband, wide-field imaging
 - High dynamic range imaging
 - Algorithm development
 - Algorithm implementation
 - Post-processing computing and networking optimization
 - On-the-fly imaging

RS RO requirements

- At least one expert from each participating group must be in residence in Socorro
 - must contribute effectively to commissioning
 - limited support for salaries or accommodation may be available
- Proposals will have three parts:
 1. Scientific justification, to be peer reviewed as part of NRAO's current time allocation process
 2. Technical section describing personnel and expertise to be involved in the residency, to be reviewed by NRAO staff
 3. Budget specifying the level and nature of any support requested from NRAO; proposals that do not require Observatory support will have a substantial advantage over those that request NRAO resources

RSRO details

- Time available:
 - Up to 25% of the time available for astronomy will go to RSRO programs (~100 hours/month)
- Residency:
 - Minimum of *one month* of resident commissioning effort required for every *20 hours* of time allocated, minimum residency of *3 months*
 - May take place before the observations, but observers must be present for observations
 - An EVLA commissioning staff collaborator will not satisfy the residency requirement
 - Graduate students will not (in general) satisfy the residency requirement
 - Resident personnel will work under NRAO management with well-defined deliverables

RS RO capabilities: per subband, no recirculation

- In the end WIDAR will provide 64 completely independent subband pairs (independent tuning, bandwidth, pol'n products, etc.)

Sub-band BW (MHz)	Number of poln. products	Number of channels/poln product	Channel width (kHz)	Channel width (kms ⁻¹ at 1 GHz)	Total velocity coverage (kms ⁻¹ at 1 GHz)
128	4	64	2000	600/v(GHz)	38,400/v(GHz)
64	4	64	1000	300	19,200
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1	4	64	15.625	4.7	300
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RS RO capabilities: per subband, with recirculation

- In the end WIDAR will provide 64 completely independent subband pairs (independent tuning, bandwidth, pol'n products, numbers of channels, etc.)

Sub-band BW (MHz)	Number of poln. products	Number of channels/poln product	Channel width (kHz)	Channel width (kms ⁻¹ at 1 GHz)	Total velocity coverage (kms ⁻¹ at 1 GHz)
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64	4	128	500	150	19,200
32	4	256	125	37.5	9,600
16	4	512	31.25	9.4	4,800
8	4	1024	7.813	2.3	2,400
4	4	2048	1.953	0.59	1,200
2	4	4096	0.488	0.15	600
1	4	8192	0.122	0.037	300
0.5	4	16384	0.031	0.0092	150
0.25	4	16384	0.015	0.0046	75
0.125	4	16384	0.0076	0.0023	37.5
0.0625	4	16384	0.0038	0.0011	18.75
0.03125	4	16384	0.0019	0.00057	9.375

Upcoming Proposal Deadlines

- VLA correlator will be turned off at the end of the next D-configuration, January 2010
 - see “EVLA Information for Astronomers” web page, at <http://www.aoc.nrao.edu/evla/astro/>
- Configuration cycle will also reverse at this time, from $A \rightarrow B \rightarrow C \rightarrow D$ to $D \rightarrow C \rightarrow B \rightarrow A$
- June 1, 2009: proposal deadline for the last VLA D-configuration
- October 1, 2009: proposal deadline for the first EVLA D-configuration
- October 1, 2009: first call for RSRO proposals

Data Rates and Volumes

Driver	Target Date	% time	Max rate (Mby/s)	Mean rate (Mby/s)	Volume (Tby/yr)
Now		100	.06	.02	0.5
PTC	Aug08	small	8	n/a	n/a
WIDAR0	Mar09	small	20	0.1	4
256 MHz bandwidth; 1024 channels max; 1 sec min dump (OSRO)	Mar10	90	0.23	0.08	2
2 GHz bandwidth; 8096 channels max; 0.1 sec min dump (RSRO)	Mar10	10	2	0.6	2
8 GHz bandwidth; 32384 channels max; 0.1 sec min dump; ~10 antennas with 3-bit samplers (RSRO)	Jun10	10	16	5	16
8 GHz bandwidth; 1048576 channels max; 0.1 sec min dump (RSRO)	Oct10	10	75	20	60
2 GHz bandwidth; 8096 channels max; 0.1 sec min dump (OSRO)	Jun11	90	2	0.6	20
8 GHz bandwidth; 1048576 channels max; 0.1 sec min dump (End of construction)	Jan13	100	75	20	600

Early testing indicates we should have no trouble supporting these data rates