EVLA Early Science: Shared Risk Observing

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Very Long Baseline Array

NRAO

Motivation

- *Early science:*
  - Want to get EVLA science capabilities into the hands of the general community as soon as possible
  - Want to minimize transition pains in going from the old VLA correlator to WIDAR (for users and the Observatory)
  - Want to encourage creative use of the emerging EVLA as soon as possible
  - Want to make our resources go as far as we can
- *Turning off the VLA correlator helps move the EVLA to completion:*
  - WIDAR commissioning limited to 10-stations until the VLA correlator is turned off
  - Enables transfer of manpower from VLA maintenance to EVLA construction project for faster completion

Shared Risk

- Want to enable early science while recognizing:
  - The EVLA is an instrument undergoing commissioning
  - NRAO has resources for delivering 8 GHz BW with uniform sub-band set-ups and reference images; special modes need extra resources
  - NRAO may not have some expertise needed for commissioning special observing modes; can potentially achieve increased capabilities sooner with community participation
  - User support limited while commissioning the EVLA

⇒ *All use of EVLA/WIDAR will be Shared Risk*

- *we'll allocate time, but no guarantee of data quality*

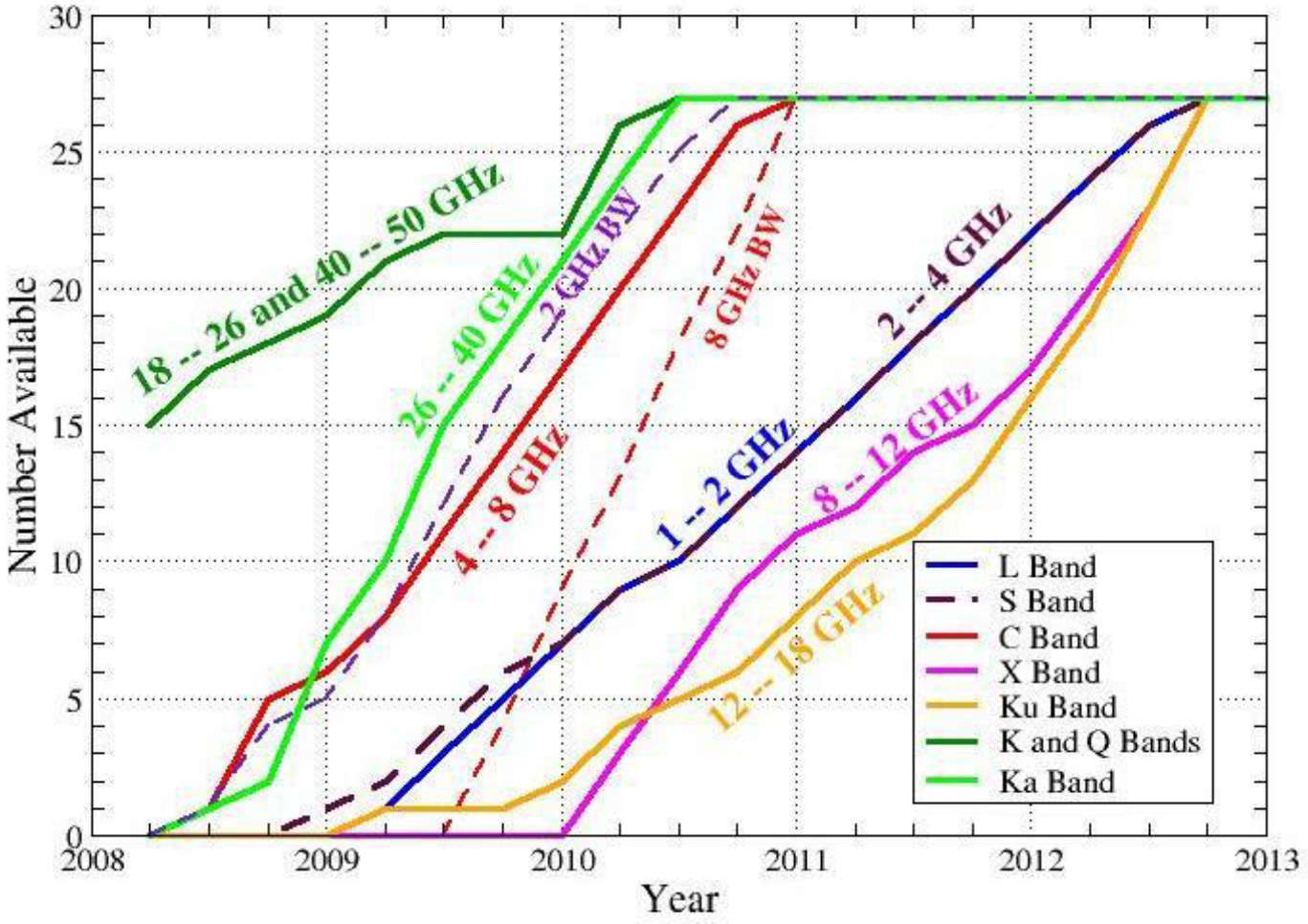
⇒ *Full access to current EVLA/WIDAR capabilities by outside users will be quid pro quo*

Programs

- We have developed two shared risk observing programs to provide early EVLA science, will run concurrently:
  - The *Open Shared Risk Observing (OSRO)* program
    - Access for the whole user community to a number of capabilities beyond those of the VLA
    - Runs from 2010 until full operations in 2013
  - The *Resident Shared Risk Observing (RSRO)* program
    - Full access to current EVLA capabilities for peer-reviewed science in return a period of residence in Socorro to help commission WIDAR, EVLA, and related software systems
    - Runs for two years, 2010-2011

EVLA Capabilities, 2009-2013

- Antennas:
- Receivers:
- Samplers:



EVLA Capabilities, 2009-2013

- Correlator:
  - First modes to be offered for general users will be a significant enhancement over VLA correlator, T1 2010
  - Then:
    - Increase bandwidth
    - Increase number of channels
    - Increase flexibility
    - Special modes
  - Rate at which these capabilities are provided are different for the two programs
  - Michael will describe the correlator growth path in more detail

Open Shared Risk Observing

- NRAO has been offering shared risk observing since the EVLA construction project began
  - New EVLA electronics
  - New on-line computing system
  - New receiver bands
  - *New correlator!*
- Initially plan to configure WIDAR in two modes that will provide significant enhancement over the VLA correlator
  - Data rates will be up to 10 times higher than current VLA maximum
  - We plan to support this for general users

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,..,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/ν(GHz)	38,400/ν(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,..,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/ν(GHz)	38,400/ν(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

OSRO details (1)

- Other technical details:
  - Spectral smoothing, Doppler tracking available
  - Integration times as short as 1 second
  - Data rates up to 10x current VLA maximum
- Time allocation
  - Via current time allocation process
- Configurations
  - Configuration cycle will be reversed when VLA correlator is turned off at the end of next D-configuration, Jan 2010
  - EVLA project then needs 6-8 weeks to switch hardware from VLA correlator to WIDAR and test OSRO observing modes with full array
  - EVLA/WIDAR configurations will run D→C→B→A, beginning with D; helps with managing increased data rates and volumes

OSRO details (2)

- Plan for increase in capabilities for OSRO driven by
  - *science: increase in BW provides biggest science impact*
  - *data rates: staged increases of an order of magnitude easiest to manage operationally*
- Capability growth:
  - 256 MHz total BW, T1 2010 through T1 2011
  - 2 GHz total BW, T2 2011 through T2 2012
  - 8 GHz total BW, T3 2012—
  - [Recirculation, special modes, 2013— (full operations)]

Resident Shared Risk Observing

- Aims to attract expert users to make the most of the early science opportunities with WIDAR, in return for commissioning help
- Capabilities available to RSRO users will be all those being commissioned at the time of observation
- Notional timescales for RSRO capabilities (depends on science requirements and coordination with EVLA software):
  - 2 GHz total BW, T1 2010
  - 8 GHz total BW, T2 2010
  - Recirculation, T3 2010
  - Increased flexibility in correlator resource allocation, T1-T2 2011
  - Special modes, T3 2011—

Potential areas of RSRO participation (I)

- Development of WIDAR 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 data reduction strategies and 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

Potential areas of RSRO participation (II)

- Development of observing and calibration strategies
  - Wideband calibration methods
  - High frequency calibration
  - Improved referenced pointing
  - Ionospheric calibration
  - Calibrator models
  - Polarimetry
  - Mosaicing
  - RFI excision

RSRO 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

EVLA Commissioning Staff Observing Program

- NRAO EVLA commissioning staff are in the best position to test and push the EVLA capabilities
- EVLA commissioning staff should have access to the same capabilities as those available through the RSRO program
- Up to 500 hours/yr will be set aside for peer-reviewed science for EVLA commissioning staff, to include short (< 10 hours) exploratory proposals from both commissioning staff and RSRO residents
- Shared risk

Reduction of SR data

- CASA will be the primary data reduction package for the EVLA
  - One of the goals of the RSRO commissioning is to commission the software
  - All RSR observers will be expected to use and test CASA at least for initial calibration
- AIPS will be available for simple OSRO datasets in the interim
  - Have already demonstrated a data path from prototype WIDAR to AIPS
  - Having multiple reduction packages has led to improvements in both CASA and AIPS

Summary

- We have announced two shared risk programs which we believe are optimized for delivering the best early science with the EVLA/WIDAR, given NRAO resources
- OSRO provides with significant improvements over current capabilities, with staged increase in data rates through early science to full operations
- RSRO provides full access to WIDAR for peer-reviewed science in return for a period of residency in Socorro to help with commissioning

Backup slides

Current VLA capabilities

Bandwidth MHz	Single Pol. Prod. No. Channels	Single Pol. Prod. Freq. Separ. kHz	Two Pol. Prod. No. Channels per pol	Two Pol. Prod. Freq. Separ. kHz	Four Pol. Prod. No. Channels per pol	Four Pol. Prod. Freq. Separ. kHz
100	16	6250	8	12500	2	50000
50	16	3125	8	6250	4	12500
25	32	781.25	16	1562.5	8	3125
12.5	64	195.313	32	390.625	16	781.25
6.25	128	48.828	64	97.656	32	195.313
3.125	256	12.207	128	24.414	64	48.828
1.5625	512	3.052	256	6.104	128	12.207
0.78125	512	1.526	256	3.052	128	6.104
0.19531	512	0.381	256	0.763	128	1.526