The EVLA: A North American Partnership

The EVLA Project on the Web
http://www.aoc.nrao.edu/evla/

10 January 2006 AAS EVLA Town Hall Meeting
The EVLA Project

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The Very Large Array (VLA)

- The VLA is the world’s premier imaging radio telescope:
  - It is the fastest, most sensitive, most flexible, most productive radio telescope in the world – as it was in 1980.
  - So – what’s the problem?

- Today’s astronomy requires a much more powerful and flexible radio telescope than the VLA.

- No significant technical upgrades since VLA’s completion – its 1970s technology severely limits scientific capability.

- Modernization of the electronics and signal processing can vastly increase the VLA’s scientific capabilities.
The EVLA Project – Leveraging the VLA

• The EVLA Project:
  – builds on the existing infrastructure - antennas, array, buildings, people - and,
  – implements new technologies to produce an astronomical facility whose top-level goal is to provide:

• Ten Times the Astronomical Capability of the VLA.
  – Sensitivity, Frequency Access, Image Fidelity, Spectral Capabilities, Spectral Fidelity, Spatial Resolution, User Access, Data Products
  – On a timescale and cost far less than that required to design, build, and implement a new facility of equal capability.

• 2000 AASC gave EVLA Project its 2\textsuperscript{nd} highest ranking for ground-based projects.
EVLA : Cost and Timescale

• An initial proposal (EVLA-I) to NSF was submitted in 2000.
  – Goal: To multiply tenfold or more all VLA capabilities, except spatial resolution.
  – Funding started in 2001 following NSB approval.
  – Completion by 2012.

• EVLA-I is a cooperative project:
  – $57M from NSF, over eleven years
  – $15M from Canada, (correlator, designed and built by HIA/DRAO)
  – $2M from Mexico, and
  – $8M from re-directed NRAO operational budget.

• A second proposal (EVLA-II) was submitted in April 2004.
  – Goal: To improve tenfold the spatial resolution.
  – $115M, over 7 years.
  – The NSF has recently (Dec 2005) declined to fund this proposal.
# EVLA-I Performance Goals

The EVLA will vastly increase the VLA’s capabilities.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>VLA</th>
<th>EVLA-I</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Source Sensitivity (1-σ, 12 hours)</td>
<td>10 µJy</td>
<td>1 µJy</td>
<td>10</td>
</tr>
<tr>
<td>Maximum BW in each polarization</td>
<td>0.1 GHz</td>
<td>8 GHz</td>
<td>80</td>
</tr>
<tr>
<td># of frequency channels at max. bandwidth</td>
<td>16</td>
<td>16,384</td>
<td>1024</td>
</tr>
<tr>
<td>Maximum number of frequency channels</td>
<td>512</td>
<td>4,194,304</td>
<td>8192</td>
</tr>
<tr>
<td>Coarsest frequency resolution</td>
<td>50 MHz</td>
<td>2 MHz</td>
<td>25</td>
</tr>
<tr>
<td>Finest frequency resolution</td>
<td>381 Hz</td>
<td>0.12 Hz</td>
<td>3180</td>
</tr>
<tr>
<td>(Log) Frequency Coverage (1 – 50 GHz)</td>
<td>22%</td>
<td>100%</td>
<td>5</td>
</tr>
</tbody>
</table>

These fantastic improvements come at a cost less than \( \frac{1}{4} \) the VLA capital investment, with no increase in basic operations cost!
Point-Source Sensitivity
Improvements : 1-σ, 12-hours

Continuum Sensitivity

Spectral Line Sensitivity

Red: Current VLA,
Black: EVLA Goals
• Continuous frequency coverage from 1 to 50 GHz a key EVLA requirement.
• Blue area shows current VLA frequency-resolution coverage.
• Green area shows future EVLA coverage.
• Yellow letters and bars show band names and boundaries.
• Two low frequency bands (74 and 327 MHz) omitted
### Key New Capabilities

<table>
<thead>
<tr>
<th>Capability</th>
<th>Details</th>
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<tbody>
<tr>
<td>Spatial Imaging Fidelity</td>
<td>$10^6$</td>
</tr>
<tr>
<td>Spectral Imaging Fidelity</td>
<td>$10^5$</td>
</tr>
<tr>
<td>Spectral Stability</td>
<td>$10^{-4}$</td>
</tr>
<tr>
<td>Spectral Flexibility</td>
<td>Can zoom in on regions of interest</td>
</tr>
<tr>
<td>Fast Time Recording</td>
<td>100 msec as installed, 2.6 msec possible</td>
</tr>
<tr>
<td>Pulsar Capabilities</td>
<td>1000 bins of 200 $\mu$sec width, 15$\mu$sec possible</td>
</tr>
<tr>
<td>Polarimetry</td>
<td>Full Stokes, full beam, noise limited</td>
</tr>
</tbody>
</table>

- New “end-to-end” data management to provide, for all astronomers:
  - Dynamic scheduling of the telescope – to optimize efficiency
  - Automatic default image generation
  - Full archive, open access to all astronomers
  - New improved post-processing
Project Status

• Four antennas currently withdrawn from VLA service, and being outfitted with new electronics.
  – Two antennas undergoing intensive testing, will be returned for VLA observing by spring.
  – All four back in service by mid-2006.

• Antennas will be cycled through the conversion process at a rate of four to five per year.

• Except for special testing, no more than three antennas will be out of service at any one time during construction phase.
Major Future Milestones

- Test prototype correlator  mid 2007
  - Four antenna test and verification system
  - Not available for science
- Correlator installation and testing begins:  mid 2008
  - Capabilities will rapidly increase until mid 2009.
- Correlator Commissioning begins:  mid 2009
  - VLA’s correlator turned off at this time
  - New correlator capabilities will be much greater at this time.
- Last antenna retrofitted  2010
- Last receiver installed  2012
New Capabilities Timescale

- The old correlator will be employed until the new correlator achieves full 27-antenna capability – mid 2009.
- Full band tuning available before 2009, on schedule shown here.
The EVLA will enable fabulous new science, as illustrated by the examples in the following three short talks.

- Peter Dewdney: Science Impact of the EVLA’s Supercomputing Correlator
- Mark Reid: Star Formation and Galactic Center
- Dale Frail: The EVLA: An NSF Facility for High Energy Astrophysics