Software Development at NRAO for Science Support

Nicole Radziwill, AD End to End Operations

Observatory Software Goals

- Deliver reliable, maintainable software systems for telescope operations, reusing concepts, designs and code wherever possible
- Broaden access to our instruments throughout the user community and provide users of NRAO research facilities with a consistent experience
- Achieve efficiency and effectiveness in software operations

Cooperation across NRAO occurs to meet these goals:

- *First goal is primary responsibility of telescope software groups*
- *Second is primary responsibility of End to End Operations*
- *Third is everyone's responsibility*

Separation of Concerns

- **Telescope Computing Groups (e.g. EVLA Computing)** – getting the instrument to function well and be useful in an observing context
  - Monitor & Control
  - Observing
  - Scheduling
- **End to End Operations (E2E)** – providing a consistent experience to the end user, integrating work with other NRAO telescopes
  - Portal for online access & communication with scientists
  - Proposal Submission
  - Data Analysis/Pipelines (including coordination of algorithm R&D)
  - Operations Analytics
  - Archive Access & Infrastructure
  - Science information on main NRAO web

External Focus

- E2E role is also differentiated from telescope software groups by its external focus, which includes:
  - Coordination with NRAO Education & Public Outreach (science web, presentation of our capabilities as One Observatory)
  - Coordination with NRAO Computing & Information Services (for example, transitioning HPC facilities from R&D to operations)
  - Coordination with NRAO Science & Academic Affairs on policy issues (e.g. data archive and proposal policies)
  - Coordination with NRAO HR (broadening access to diverse groups)
  - Establishment/maintenance of external relationships (Pittsburgh Supercomputer Center, NCSA)
  - Pursuit of external, non-programmatic funding

High-Performance Computing (HPC)

- Making better use of HPC (e.g. clusters, GPUs, FPGAs) is critical to meeting the needs for data handling and data processing, especially for EVLA
- We are working to ensure that NRAO software engineering staff can develop and expand their HPC skills
  - More involvement and participation in national HPC community
  - Need to leverage national facilities (NCSA, PSC, NMCAC etc)
- Algorithm R&D proposal submitted to NSF in July
  - ½ FTE at supercomputer center dedicated to NRAO for 5 yrs
  - Access to 2 postdoc and 2 grad students each year for support

Major Subsystems

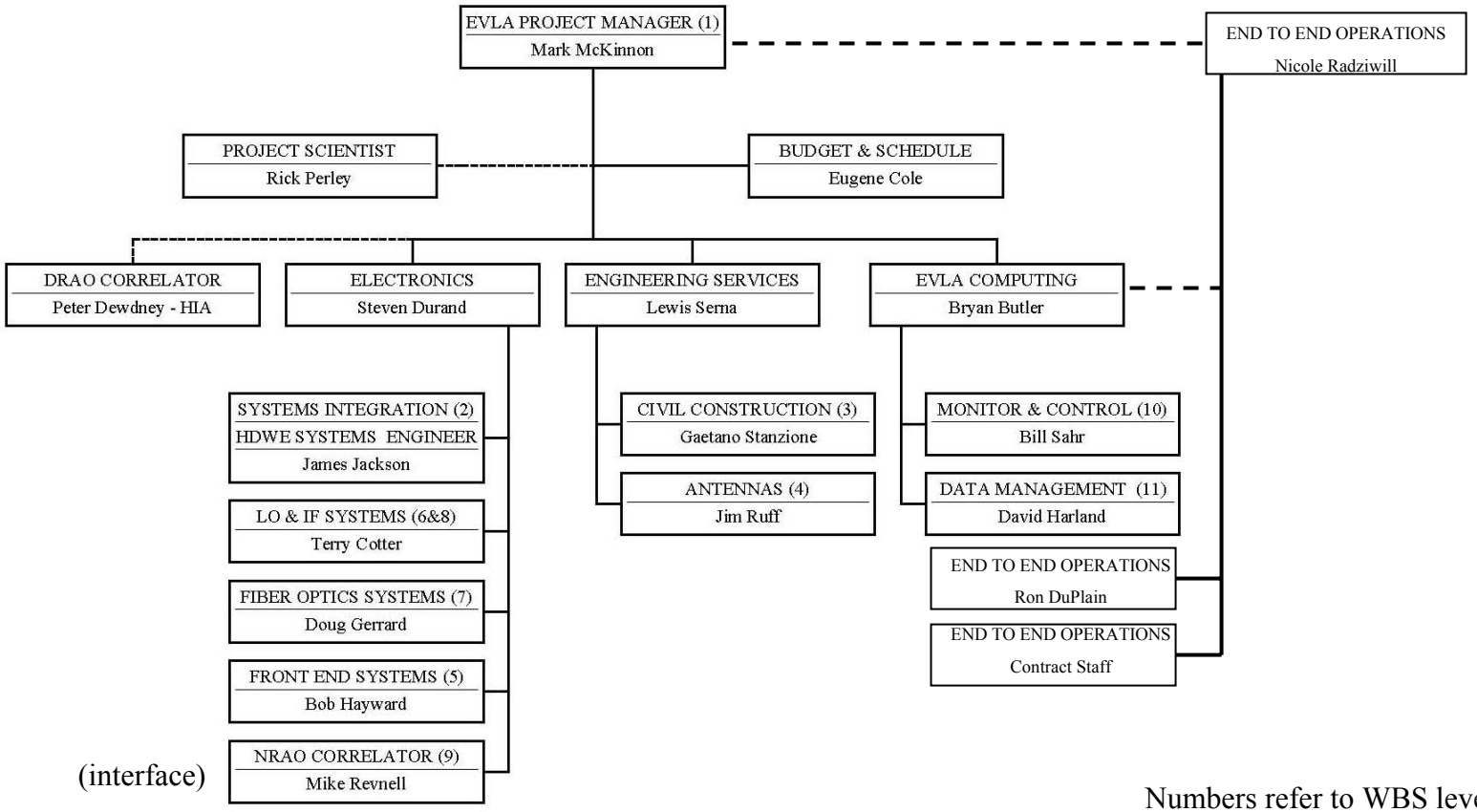
- High Level Architecture (HLA)
- Portal (user authentication/gateway)
- Proposal preparation and handling (PST/PHT)
- Observation preparation (OPT)
- Array Scheduling (OST)
- Archive access & infrastructure (AAT)
- *Activities & current status of Data Analysis to follow*
- *Algorithm R&D technical details discussed later*

E2E Contribution

- High Level Architecture (HLA)
- **Portal (user authentication/gateway)**
- **Proposal preparation and handling (PST/PHT)**
- Observation preparation (OPT)
- Array Scheduling (OST)
- **Archive access & infrastructure (AAT)**
- **Data Analysis & Algorithm Development**

- *Primary EVLA subsystems will be discussed by B. Butler*
- *E2E subsystems will be discussed by N. Radziwill*

EVLA Project Organization



Numbers refer to WBS level 2 tasks.

E2E Resources

Nicole Radziwill, AD End to End Operations
Ed Fomalont, Project Scientist, End to End Operations

Algorithm Research & Development

Sanjay Bhatnagar
Kumar Golap
George Moellenbrock
Steve Myers (25%)
Ed Fomalont
Urvashi Rao-Venkata
Abittur
Juan Uson, Bill Cotton, Rob Reid, Brian Mason, Scott Ransom

Data Management & High Performance Computing

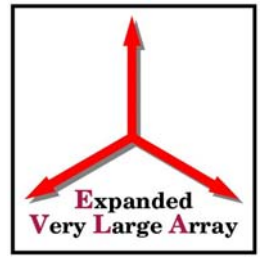
Gareth Hunt
Darrell Schiebel
Boyd Waters
Wes Young
John Benson
Ron DuPlain
Joe Brandt, Amy Shelton (25%)
Eric Sessoms
Libby Miller
Pat Murphy, Stephan Witz (50% each in webmaster position)
Tony Remijan

Observatory-Wide Science Support

McMullin/Replacement
David King
Laura Glendenning
Dana Balser (50%)
Jared Crossley (75%)
Ashish Arte and Paul Schock at Open Sky Software in Austin, TX working on Interactive Services/PST/etc.
Darren Hoyt at Category 4 Solutions in Charlottesville, VA working on web and design issues

Individuals in boldface are full-time NRAO employees; others are fixed-term or contract employees.

Individuals in italics participate in these activities in their research time and are not committed to specific deliverables.

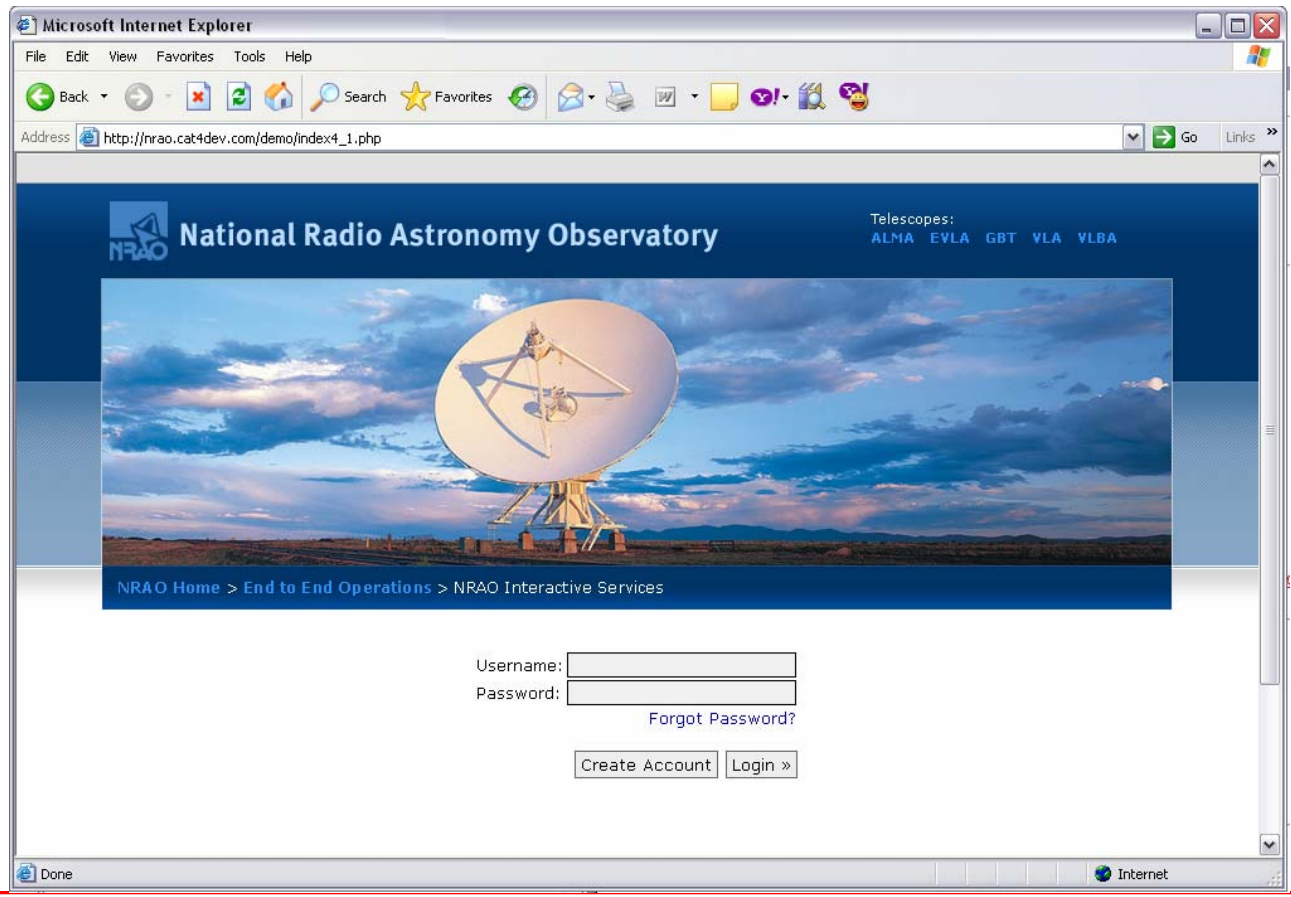


E2E Contributions

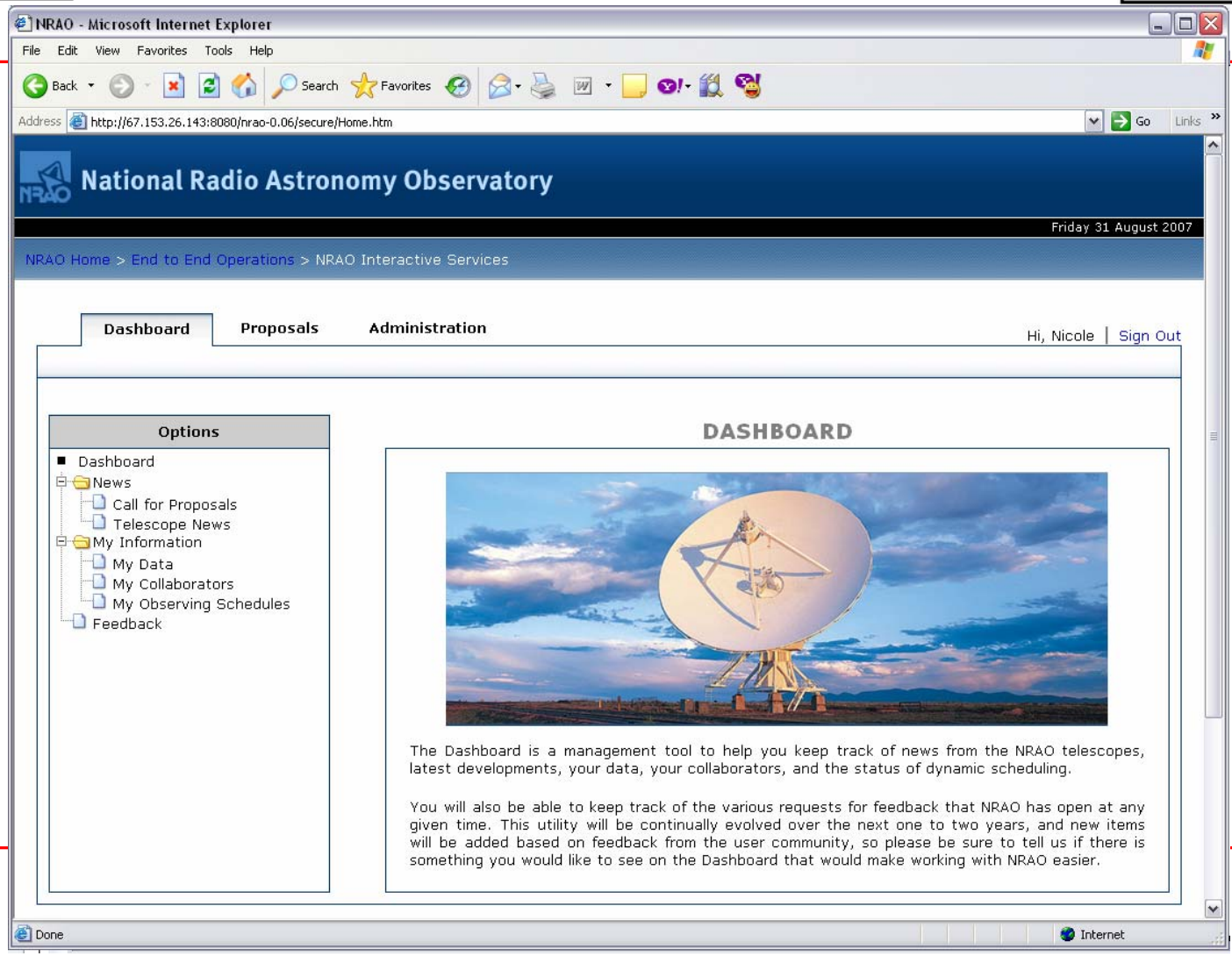
Interactive Services Portal
(http://my.nrao.edu)

- Initial version of portal developed by EVLA Computing
- Used in a number of proposal calls
- Being used for development of Observation Preparation Tool, Observation Scheduling Tool, Operator's Screen
- Turned over to E2E/OpenSky at June 2007 proposal deadline; upgraded for October 1 proposal deadline, after which EVLA applications can be retrofit to updated portal

Portal Login



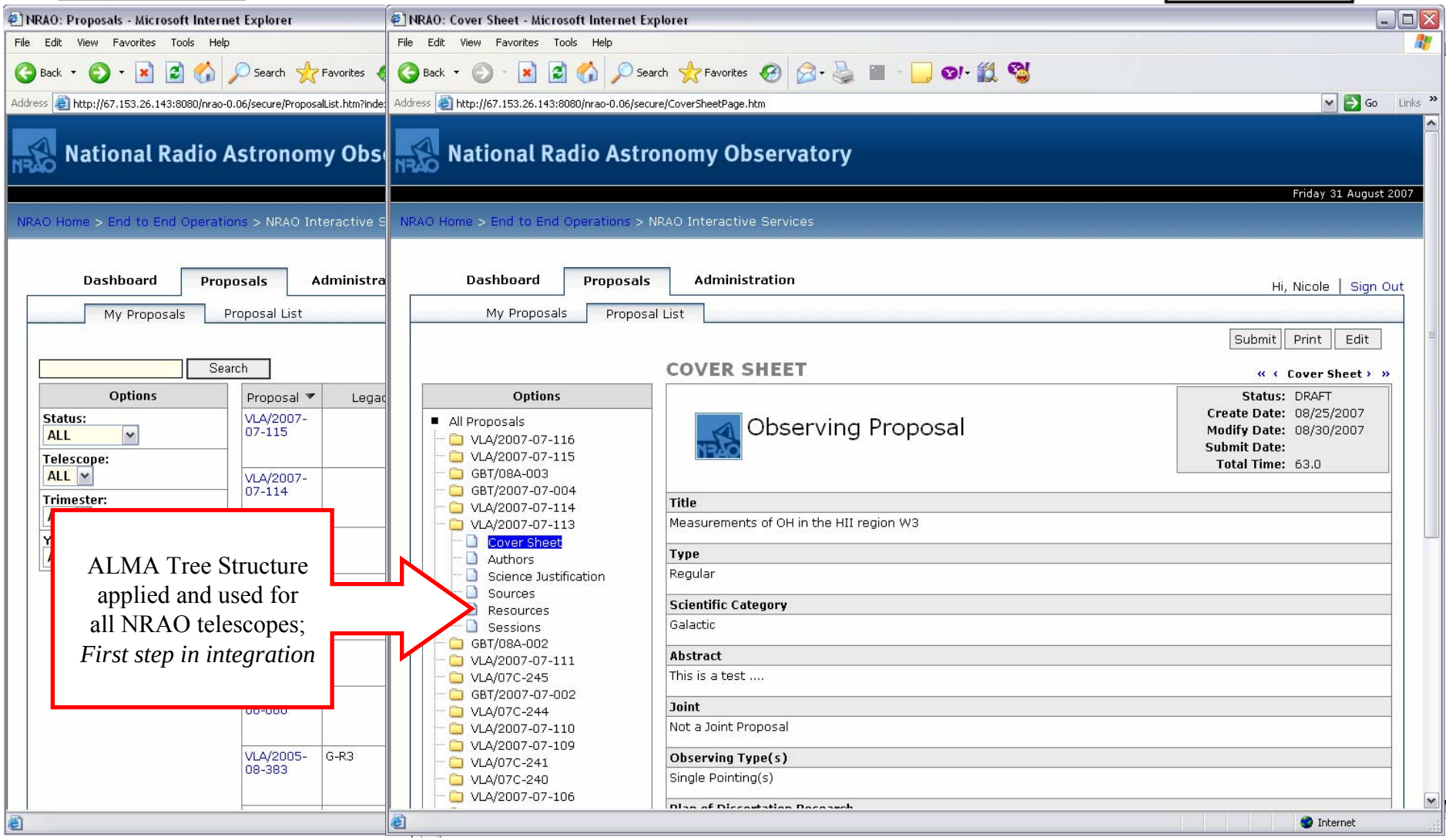
Portal Dashboard



Proposal Preparation (PST) & Handling (PHT)

- Originally developed by EVLA Computing and used in a number of proposal calls for VLA and GBT
- Turned over to E2E/OpenSky for June 2007 proposal deadline; upgraded for Oct 2007
- **Must still get EVLA hardware definitions supported (notably WIDAR)**
- Full proposal handling system & VLBA integration planned for February 2008 proposal deadline
- Results from dynamic scheduling required to transition from instrument-centric view (sources, resources, sessions) to science objectives view (ALMA approach)

Proposal Preparation & Handling



Archive access (AAT)

- Searches and retrieves data from the disk archive
- Raw data and processed products made available
- Will support Virtual Observatory (VO) access on the processed products
- EVLA will have common science data model and already has archive storage software and hardware (NGAS) in common with ALMA, so archive access tool can and will be common

AAT - VLA/VLBA Prototype

- VLA and VLBA raw data currently accessible via web application, available and continually refined since October 2003
- Non-proprietary data openly available
- Proprietary data made available via portal login or staff-generated “key”
- Both simple (Project ID, for example), and complex (akin to VO cone search) searches supported
- More data downloaded via this mechanism than is taken real-time at the VLA (~3 GB/day)
- Screen shots of recent work to follow

List NRAO Archive Query Parms - Mozilla Firefox

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List NRAO Archive Query Parms - Mozilla Firefox

List NRAO Archive Query Parms - Mozilla Firefox

m82 -- Voogle Search - Microsoft Internet Explorer

List e2e VO Data Files - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites

Address http://archtest.aoc.nrao.edu/archive/ArchiveQuery?QUERY_ORIGIN=NRAOARCHIVE&MAX_ROWS=100&SUBMIT=Submit+Query&QUERYTYPE=IMAGE&PROTOCOL=HTML&VERB=0&SOURCE_ID=m82&SRC_SEARCH_TYPE=SIMBAD%2BNED+Resolve

Go Links

Image Search Results

Show Query Parameters

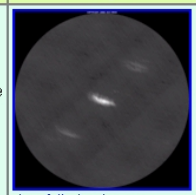
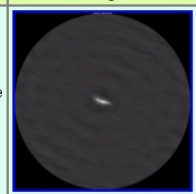
Displaying 5 Rows out of 5 Found

(Required) Enter your email address :

Enter download destination : /home/ftp/e2earchive

Download Checked Files

More Options
Help

Basic Info	UV Info	Image	Image Info	Links
Field : J095552.2+694046 09h55m52.20s +69d40'49.0" (J2000 image center) 4.860 GHz (C-band) Sky offset = 0.0 arcmin	Telescope : VLA Collection : VLAPipeline Config : B Polarization : FULL Observed : 1999-10-31	 view full size image	Stokes : I Beam = 4.3661 arcsec fov: R = 05'59.2" rms = 0.134 milliJy	☐ FITS image ☐ Calib. u-v data
Basic Info	**UV Info**	**Image**	**Image Info**	**Links**
Field : J095551.7+694046 09h55m51.71s +69d40'48.4" (J2000 image center) 4.860 GHz (C-band) Sky offset = 0.0 arcmin	Telescope : VLA Collection : VLAPipeline Config : B Polarization : FULL Observed : 1999-12-04	 view full size image	Stokes : I Beam = 1.3136 arcsec fov: R = 09'15.3" rms = 0.038 milliJy	☐ FITS image ☐ Calib. u-v data
Basic Info	**UV Info**	**Image**	**Image Info**	**Links**
Field : J095551.7+694046	Telescope : VLA			

Trusted sites

Project: AH0380 Observer: Ho, Paul Source: M82 (42 observations at the VLA)

Project: AK0309 Observer: Sramek, Richard A. Source: M82 (39 observations at the VLA)

1 2 3 4 5 Next

2007 raw Scans Logs

2007 raw Scans Logs

2007 raw Scans Logs

2007 raw Scans Logs

Done

Internet

Archive Progress & Plans

- Updated archive access tools for VLA/GBT/12m/140ft are being made available in Fall 2007
- Access to observing scripts and logs made available for VLA Fall 2007 and GBT Spring 2008
- E2E providing support for archive development required to support WIDAR in Summer 2008
- Interface between shared and non-shared EVLA subsystems is through archive

Data Analysis with CASA

- Exciting year, with the beta release coming up next month, and phase-in of user support for the beta test group
- “Train the trainer” and tutorials planned this winter and spring
- Details about the package and its current capabilities to be provided by Joe McMullin

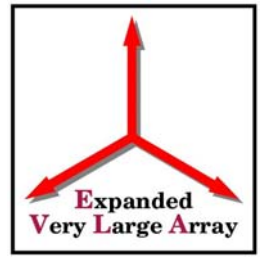
Algorithm R&D

KEY ISSUES

- Processing is inefficient at present, 10-50x speedup beneficial by itself
- Larger data volumes will require faster processing
- More sophisticated algorithms required to achieve higher dynamic ranges

- **2007.8 to 2008.4 (before WIDAR)**
  - CASA betas, ramping up user support, infrastructure support, continued EVLA debugging in AIPS
  - Continued algorithm development of stationary (parallactic angle) primary beam effects
  - Begin HPC investigations with November 2007 workshop; substantial progress can be made here
- **2008.4 to 2010 (debugging WIDAR, first science)**
  - WIDAR correlator tests: AIPS → CASA transition to debugging, checking
  - Commissioning basic correlator modes with 'simple' science
  - Aggressively pursue wide-field/wide-bandwidth imaging, multi-line spectral imaging
  - HPC - I/O strategies determined and beginning implementation
- **2010 to 2013 (evolving into mature EVLA capabilities)**
  - Shared-risk science support → algorithm development motivator
  - HPC and I/O further improvements to handle harder EVLA cases
  - Progress on 10^5 DR, wide-field, wide-bandwidth imaging, full spectral line support.

Backup



Algorithm R&D/HPC Issues for EVLA

	Low Frequency	High Frequency
All Cases (observation dependent)	• **Pointing Self-Cal** • **Non-isoplanatic calibration issues (remove ionospheric/tropospheric effects that limit dynamic range)** • **RFI mitigation (detection, flagging, etc.)**	Ionosphere not an issue • Removing tropospheric effects
Continuum Imaging	• **Wide-band high fidelity imaging**	• **Data volume/processing times**
Continuum Imaging (Full Polarization)	• **Wide-band high fidelity imaging** • **Wide-field full polarization imaging (many options; primary need is to make the processing more efficient)** • **Wide-band wide-field full polarization imaging**	• **Data volume/processing (4 data streams as compared to single polarization continuum imaging)**
Spectral Line Imaging	• **Data volume/processing**	• **Data volume/processing (more spectral lines, more channels)**
Spectral Line Imaging (Full Polarization)	• **Data volume/processing (4 data streams as compared to single polarization continuum imaging)**	• **Data volume/processing (more spectral lines, more channels, 4 data streams)**
All Cases (systematic improvement of imaging process)	• **Multi-scale deconvolution/MEM**	

Color Key:

Green – problem is well in hand, many options available

Blue – problem more complex, but solvable with time

Orange – problem much more complex, must focus resources

Red – most complex problems, dependent on other solns