Post-processing

Bryan Butler, for Joe McMullin

EVLA Post-processing

Mission:

- Primary purpose is to provide facilities for post-observational scientific reduction of ALMA and EVLA data

Facilities must be:

- Scientifically complete/correct
- Robust
- Acceptably fast
- Easy to use
- Able to support both scripted and interactive use

Requirements

Requirements Key Areas:

- General Requirements and Interaction
- Interface
- Data Handling
- Calibration and Editing
- Imaging
- Data Analysis
- Visualization
- Special Features

Driven by requirements documents:

  - ALMA Offline Data Processing Requirements
  - EVLA Data Post-processing Software Requirements
  - 2/3 of requirements are common!

Detailed tracking on the combined projects' requirements (common to both projects and the deltas between projects)

Software Packages

Packages:

- Legacy AIPS++ code base for development (changing to CASA - more on that later)
- AIPS used for validation, algorithm and display development (e.g., automated flagging), support of EVLA hardware tests

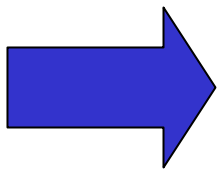
AIPS++ - Transition to CASA

- Users reluctant to embrace AIPS++ as a post-processing package, based on problems with robustness, speed, functionality, and the user interface
- Decision to halt public releases of AIPS++ made in 2004
- Now concentrating on above problems; also working on modularity of code, a change from Glish to Python as the binding scripting language, and help/documentation
- New package named CASA - Common Astronomical Software Applications
- Care being taken regarding releasing the new package openly, to avoid the problems of the past

Framework Improvement

AIPS++:

- Glish interface; relatively unknown, unsupported outside of NRAO
- Tasking system based on Glish
- GUI system based on Glish/Tk; limited widgets, **not robust!**
- Difficult for external developers to contribute
- Multi-CD binary distribution
- Large monolithic libraries with cross dependencies
- Freeze 2nd half of 2006



CASA:

- Hierarchical set of small libraries with clearly defined dependencies
- Inherits all application code improvements in robustness and performance.
- Smaller memory footprint/startup time
- Python interface (community standard); IPython
- Binding to Python, ACS; other frameworks enabled

CASA Usage Status

- Has been tested internally by NRAO scientists in preparation for the 2006 ALMA test.
  - Early demos provided bi-monthly to the NAUG at:
    - http://casa.nrao.edu/gettingstarted.shtml
  - 6 scientists used and reported on it – enabled deployment for the ALMA test.
- Was deployed and reviewed by four ALMA testers
  - http://projectoffice.aips2.nrao.edu/ALMA2006.01/ALMA2006.01.html
- The user interface was reviewed and commented on by 8 NRAO scientists
  - User Interface is being refined/further developed based on the user interface report:
    - http://projectoffice.aips2.nrao.edu/uiwg-report.pdf
- Will be used exclusively by the ALMA Pipeline Heuristics Team (second half of 2006)
- CASA will have replaced AIPS++ within NRAO (developers and NAUG testers) this year.

CASA Development/Release Plan

2006

- NRAO: NAUG testing (AIPS++)
- Community: Project tests
- ALMA: external science testing: +single-baseline commissioning test) (*CASA*)
- ALMA: external science testing: +single dish reduction (*CASA*)
- ALMA: commissioning support (*CASA*)
- ALMA/EVLA: user interface review (*CASA*)
- EVLA: external science testing: +full polarization imaging; antenna pointing calibration
- **2006.5 AIPS++ frozen**
- ALMA: Pipeline Heuristics Use of CASA
- NRAO: **CASA** initial beta deployment (internal)

2007

- NRAO: User support (*CASA*)
- ALMA: commissiong support (CASA)
- EVLA: external science testing: + RFI/automated flagging (*CASA*)
- ***ALMA: P1 SSRs complete***
- NRAO: **CASA** second beta deployment (internal)

2008

- EVLA: external science testing: + wide band calibration imaging (*CASA*)
- ALMA: commissioning support
- ***EVLA: P1 SSRs complete***
- **Community: CASA** mature - limited release to outside users

2009-2010

- ALMA/EVLA: commissioning support
- **Community: CASA released/distributed for early ALMA/EVLA science**

2011

- **Community: CASA** released/distributed; full user support ***(ALMA/EVLA: P1/P2s)***

Ability to Deliver

The Science Software Group (SSG) has demonstrated the ability to meet major milestones:

- Heavily reviewed in annual VC and UC meetings, as well as ALMA CIPT, ASAC and EAC reviews
- Of 21 major milestones presented at ALMA CDR2 in July 2004 for the period up until now, 15 were met on time, 2 were changed and met on time, and 4 were met, but late
- Over past three years, 3 formal ALMA CDRs, 4 formal ALMA releases, 3 formal ALMA tests, and 1 formal EVLA test have been successfully completed
- Note that EVLA benefits substantially from ALMA-driven development of CASA, since common requirements are met (remember that 2/3 are common), as well as the higher-level requirements of robustness, speed, and usability.

SSG - Organization

The SSG is a group within the Interferometry Software Division (ISD) - key personnel for ISD and SSG are:

- G. van Moorsel (EVLA), B. Glendenning (ALMA) - Heads of Computing; ISD Co-managers
- M. Rupen (EVLA), Debra Shepherd (ALMA) - Project Scientists for Computing
- J. McMullin, K. Golap - Group Management
- S. Myers - Group Project Scientist

ISD functions now in the new e2e Operations Division:

- N. Radziwill, E. Fomalont - manager and scientist

SSG - Staffing

- **NRAO:** 5.0 FTEs (including management; split 60/40 between ALMA & EVLA)
- **EVLA-specific:** 1.5 FTEs (Imaging algorithms, Data flagging)
- **ALMA-specific:** 5.5 FTEs (Application development, Data Model, Data Model Interfaces, Data Capture process)
- **NSF grant:** 1.0 FTE (visualization; concludes 2007.8)
- More detail on backup slide, if needed

Imaging Algorithm Developments

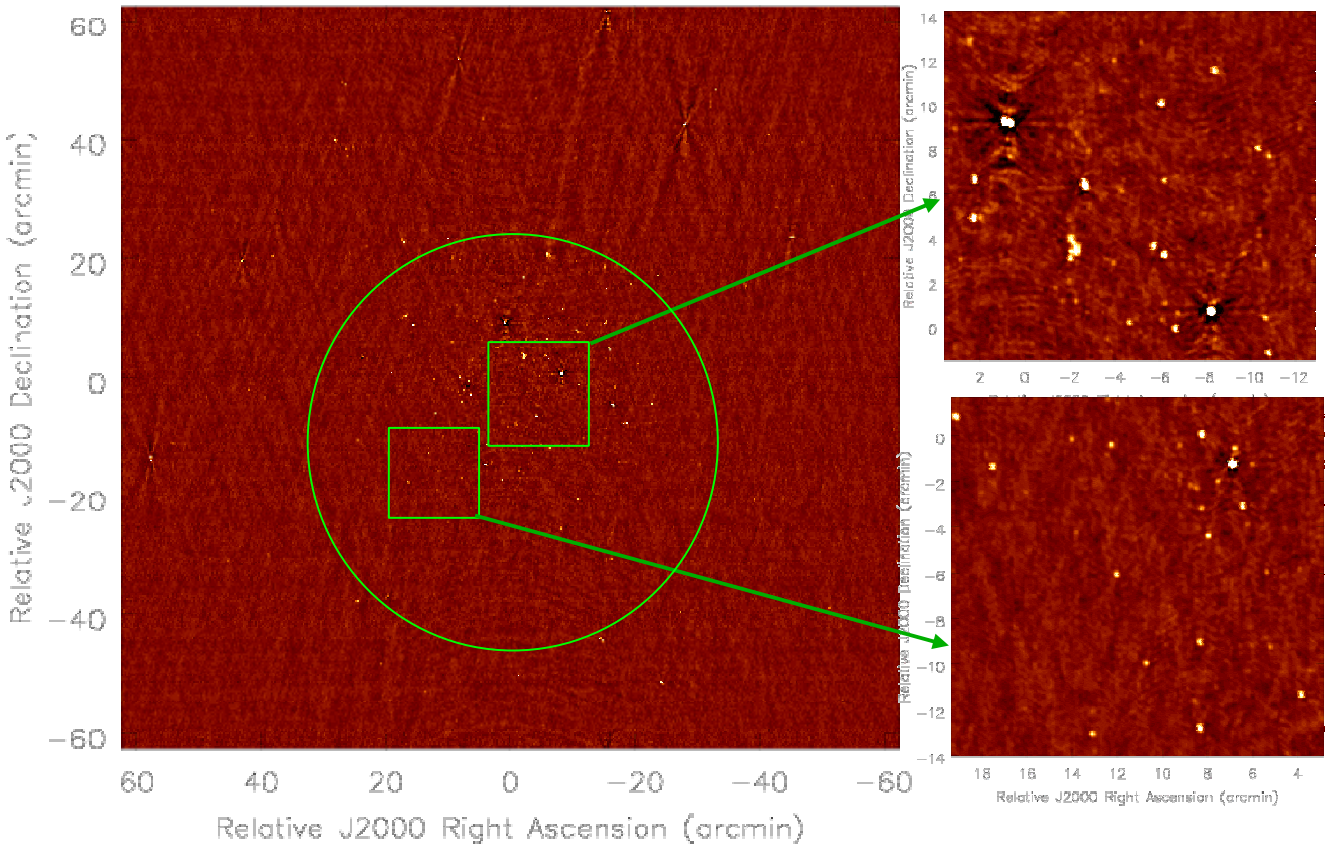
- Wide field imaging
  - W-projection algorithm: An improvement over the image-plane faceted algorithm: 3-10x faster
  - Implemented [Done/Tested] (EVLA Memo 67; Cornwell, Golap, Bhatnagar)
- Primary Beam (PB) corrections
  - PB-projection algorithm [Done/Testing]
    - PB/In-beam polarization correction (EVLA Memo 100; Bhatnagar, Cornwell, Golap)
    - Pointing SelfCal [Testing] (EVLA Memo 84; Bhatnagar, Cornwell, Golap)

Imaging Algorithm Developments

- Initial investigation for deconvolution [Done] (EVLA Memo 101, Rao-Venkata & Cornwell]
  - Multi-frequency Synthesis (MSF)/Bandwidth synthesis/Chan. Avg. inadequate for EVLA 2:1 BWR
  - Hybrid approach promising for DR ~ 10000
- Scale & frequency sensitive deconvolution [Work in progress]
  - The code in C++ works – but as a Glish client
  - Extend it for frequency dependent components

Wide Field Imaging

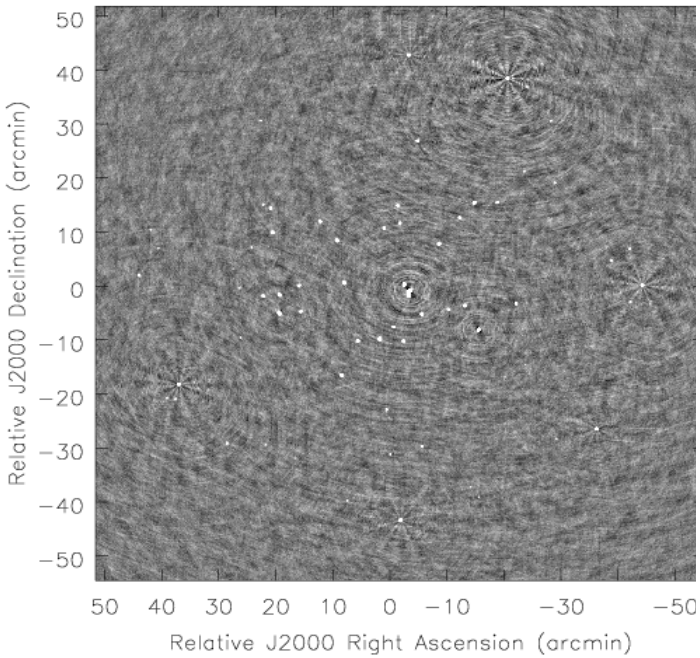
- W-projection: Adequate for EVLA imaging



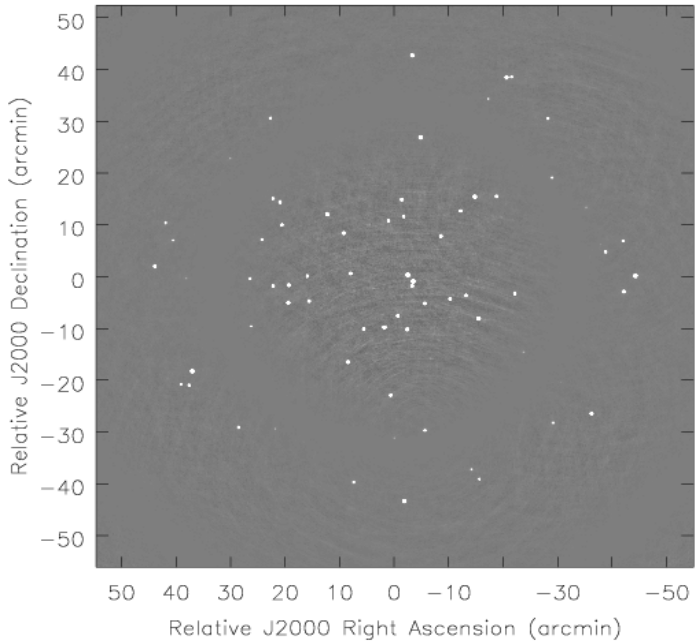
- Errors not due to w-term
- Limited by pointing errors/PB-rotation?
- Errors in the first sidelobe due to PB-rotation

PB Corrections - Stokes I

- Correction for PB rotation & polarization effects



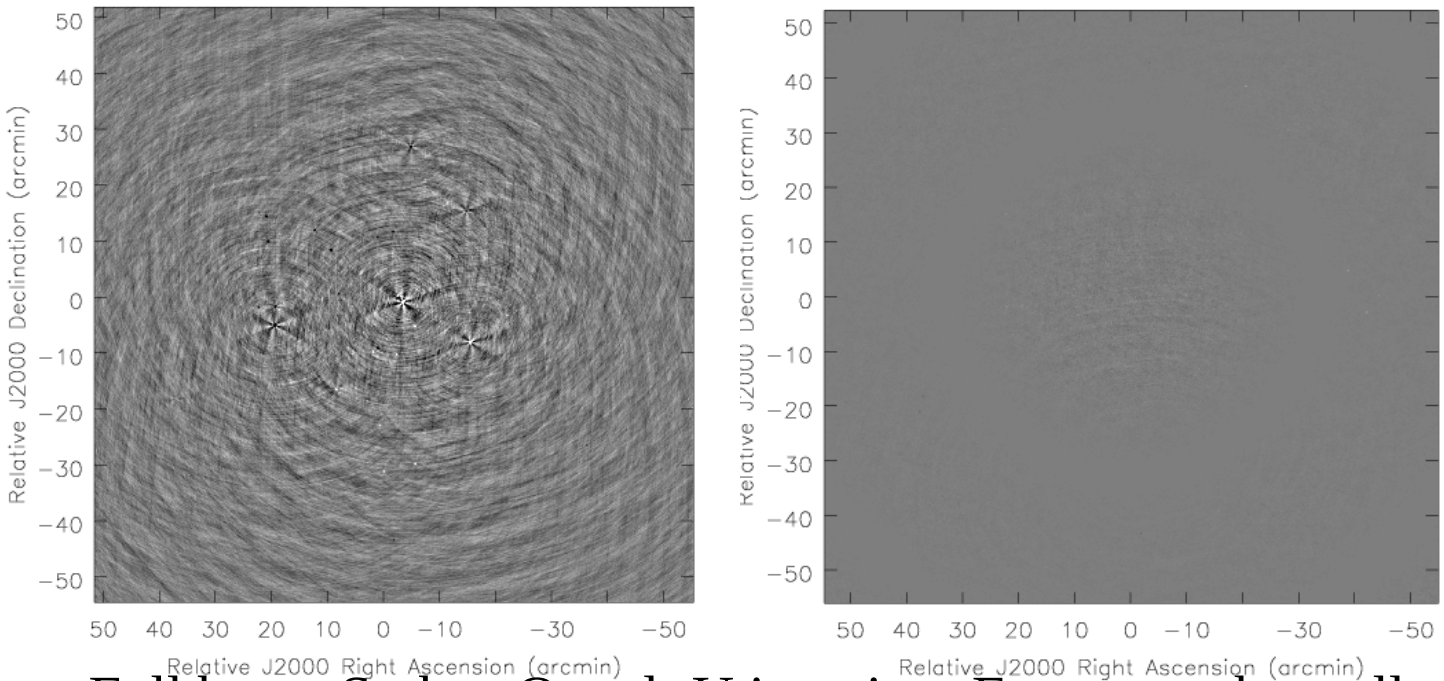
Before correction for pointing and PB-rotation



After correction for pointing and PB-rotation

PB Corrections - Stokes V

- Correction for PB rotation & polarization effects



- Full beam Stokes-Q and -U imaging: Errors much smaller
- Corrections can be similarly done

Testing

- NRAO AIPS++ Users' Group (NAUG)
  - Progress reports and tests of most recent internal release
  - Requests for testing and comments
  - First look at python interface
- NRAO Algorithms Working Group (NAWG)
  - Discussion of algorithms and progress
- Includes Myers, *Brisken,*Brogan, *Chandler,* Fomalont, *Greisen,* Hibbard, *Owen, Rupen,* Shepherd, *Whysong,* + developers

Testing - Leveraging ALMA

- EVLA participation in ALMA formal tests
  - Outside ALMA testers with VLA expertise
  - ALMA2006.01-4 (python + single baseline calibration) included Brisken, Owen, Rupen
  - Goals
    - CASA experience
    - Influence common development (interface, for example)

Testing - Leveraging ALMA

- Joint development of common 2/3 requirements
  - User Interface Working Group (Apr 06)
    - Refine requirements for user interface
    - Myers, Brogan, *Brisken, Greisen,* Hibbard, *Owen, Rupen,* Shepherd, *Whysong*
    - Draft results on Web
- Joint planning
  - Draft proposal for gradual shift of CASA from development to user support, including scientific staff use, documentation, and hand-holding

EVLA-Specific Tests

- May-July 2005: w-projection
  - First step in the Big Imaging Problem
  - Generally good performance (speed, robustness) but lots of ease-of-use issues
  - Myers, Brisken, Butler, Fomalont, van Moorsel, Owen
- Currently concentrating on
  - Long lead-time items (high DR imaging)
  - Hardware driven items (prototype correlator)
  - Shift to user-oriented system

EVLA Fall 2006 Test

- User interface
  - Revised UI (tasks etc.)
  - Revamped module organization
  - New documentation system
- Reading and writing SDM
  - ASDM → CASA MS → UVFITS → AIPS
- Basic calibration, including calibration of weights
- "Testers' choice" of data sets, in addition to common ones

EVLA Fall 2006 Test

- Data examination
  - Basic plots (mostly a survey of existing code)
  - First look at stand-alone viewer (qtview)
- Imaging
  - Widefield imaging (w term, multiple fields)
  - Full polarization imaging
  - Pointing self-calibration

EVLA Winter 2006/7 Test

- Not a formal test
- NAUG and "dedicated" staff
- User interface discussions/testing
- Documentation
- "EVLA stress test:" basic calibration and imaging of a many-channel data set, both in CASA and in AIPS

EVLA Spring 2007 Test

- "Format test" (SDM)
- Focus on calibration and data examination
  - Flexible, simple-minded, quick displays
  - Wideband issues
- Driven by need to support initial basic modes (like big spectral line cubes), and to learn from the new hardware (WIDAR + wide-band feeds)

Risks

- Any reduction in staffing levels within the SSG can impact delivery schedule
  - Staff retention is key; AIPS can potentially be used to bridge any delivery schedule gap
- The necessity to do both software development and active user support stretch already thin resources
  - Convert to NRAO staff scientists being front-line user support, just as for AIPS
- User interfaces are notoriously difficult to develop (and gain acceptance)
  - Extensive testing and feedback into development is critical
- Significant scientific staff resources are required for testing, support, and documentation; not present currently
  - NRAO intends to redirect or hire new scientific staff to address this
- Science Data Model complexity can impact delivery schedule
  - The SDM must be critically evaluated for propriety and agreed to by both ALMA and EVLA (and potentially GBT)
- Algorithm development and data rates and computation
  - Algorithm development group (NAWG) work ongoing; data rate and computation problems addressed with additional hardware

Resources - Details

	FTEs			Comments
NRAO (SSG)	**4.75 [5.75]**			**Project Scientist: Steve Myers**
Sanjay Bhatnagar	0.75	Astronomer	Algorithm Development (EVLA)	
Kumar Golap	0.75	Astronomer	Application Code	**Application code: common to ALMA&EVLA**
Joe McMullin	0.75	Astronomer	Management	
George Moellenbrock	0.75	Astronomer	Application Code	
David DeBonis	**1.0**	**Software Engineer**	**System**	**Began 2004-05; depart:2006-01**
Darrell Schiebel	1.0	Software Engineer	System	
Wes Young	0.75	Software Engineer	System	
ALMA	**4.3 [5.3]**			**2.3 FTE in-kind**
Gary Li	**1.0**	**Software Engineer**	**Application Code**	**0.5 FTE in-kind; Began 2004-03**
Raymond Rusk	1.0	Astronomer	Application Code	
Tak Tsutsumi	1.0	Astronomer	Application Code	1.0 FTE in-kind; Began 2005-03 (ACA)
Honglin Ye	0.5	Software Engineer	Application Code	Began 2005-07 (visualization)
Michel Caillat	0.8	Software Engineer	ALMA Data model, simulation	0.3 FTE in-kind
Francois Viallefond	0.5	Astronomer	ALMA Data model, simulation	0.5 FTE in-kind
Heiko Hafok	0.5	Astronomer	ALMA Data Capture	Began 2003-12
NSF grant	**1.0**			
David King	1.0	Software Engineer	visualization	(concludes 2006-05)
Other	**0.5**			
Urvashi Rao	0.5	Astronomer	Algorithm Development (EVLA)	Began 2004-09 (9 month appt)
Total	**10.05 12.55]**			