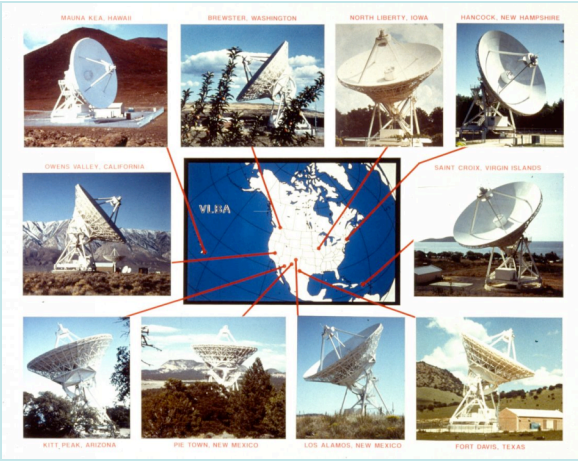

VLBA SENSITIVITY UPGRADE REQUIREMENTS

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VLBA SENSITIVITY UPGRADE

- Increase bandwidth to 1 GHz (4 Gbps)
  - Current bandwidth 32 MHz sustainable, 128 MHz peak
  - Sensitivity increase by factor >5 (sustainable rates)
  - New digital backend (DBE)
  - New recording system (Mark5C)
  - New software correlator (DiFX)
  - The major cost is disk supply
- Improved 22 GHz amplifiers
  - About 38% sensitivity gain
  - MPIfR funding

UPGRADE STATUS

- 22 GHz improvement finished Jan. 2008
- ROACH board for the DBE under test
  - Operations software and FPGA personalities needed
- Mark5C - Most hardware ready, needs 10 Gb ethernet interface and control software
- DiFX correlator working
  - Initial cluster was purchased
  - Operations software under development
- Expect usable system in summer 2009
  - Disk supply for full operations ~2011
  - Funding needs to be identified

DATA SET SIZES

Observation	Bandwidth (MHz/pol)	Channel Bandwidth (MHz)	Average Time (sec)	Total size (Gbytes) Full stokes
Current Continuum	32	0.5	2.0	2
Upgraded Continuum	512	0.5	2.0	32
Spectral line (Water magamaser)	150 (2000 km/s)	0.015 (0.2 km/s)	2.0	160
Full primary beam at 5 Ghz	512	0.0058	0.017	325000

Algorithms Needed ASTROMETRY

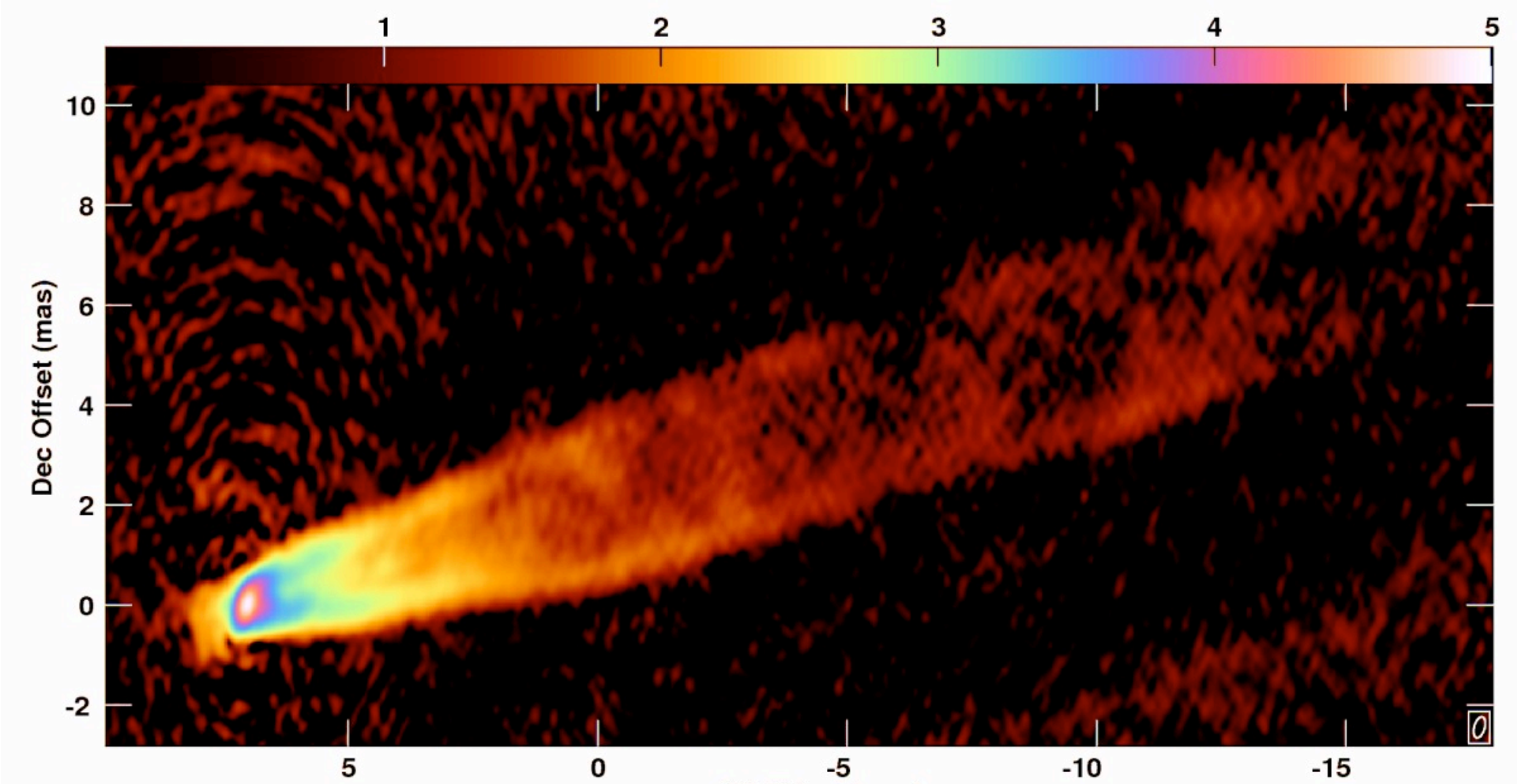
- Astrometry is one of the most important observation types for the VLBA
- Goal to reach 5 μas accuracy relative to calibrator
- Improved troposphere calibration
  - Use numerical weather models
  - Improved methods to use calibrators
- Improved ionosphere calibration
  - Better ionosphere models from GPS etc.

Algorithms Needed
Imaging with Sparse UV Coverage

- MFS
  - Must deal with highly variable spectral index
  - Use multiple bands?
- Robust self-cal/imaging convergence
  - Problem is with complex sources
  - Many iterations make no, or negative progress
  - NNLS? Other algorithms
  - Would like to automate, but difficult now
- Already use robustness and multi-scale clean

AN EXAMPLE

- Nearing the complexity limit with 45 baselines
- 23 full-track image stack - M87 at 43 GHz



Algorithms Needed
WIDE FIELD IMAGING

- Data sets and images are too big with methods used on smaller baselines
- Typical methods now:
  - Multiple correlation phase centers
  - Target sources seen in lower resolution images
- Is there a better way?

Algorithms Needed VARIABLE SOURCES

- Some VLBI sources change during the observations (eg. SS433)
- Typical methods now:
  - Image from short periods of data (poor UV cover)
  - Restrict resolution
- Would be better to include the source changes in the imaging process.
  - This might be related to MFS with variable spectral index

Algorithms Needed
EVPA CALIBRATION

- All VLBI calibrators are variable and resolved
- VLA monitoring helps, but many sources vary too fast for the current style
- Alternatives (surely there are more)
  - Use cross-hand autocorrelations
  - Use pulse cal tones or transmitted signals
  - Improve the monitoring of a few sources
  - Calibrate carefully once and assume constant

ODDS AND ENDS

- Data formats for pulsar bins
- Facilitate movie making
- “CALC in AIPS” (or whatever package)