The Variables And Slow Transients (VAST) Survey

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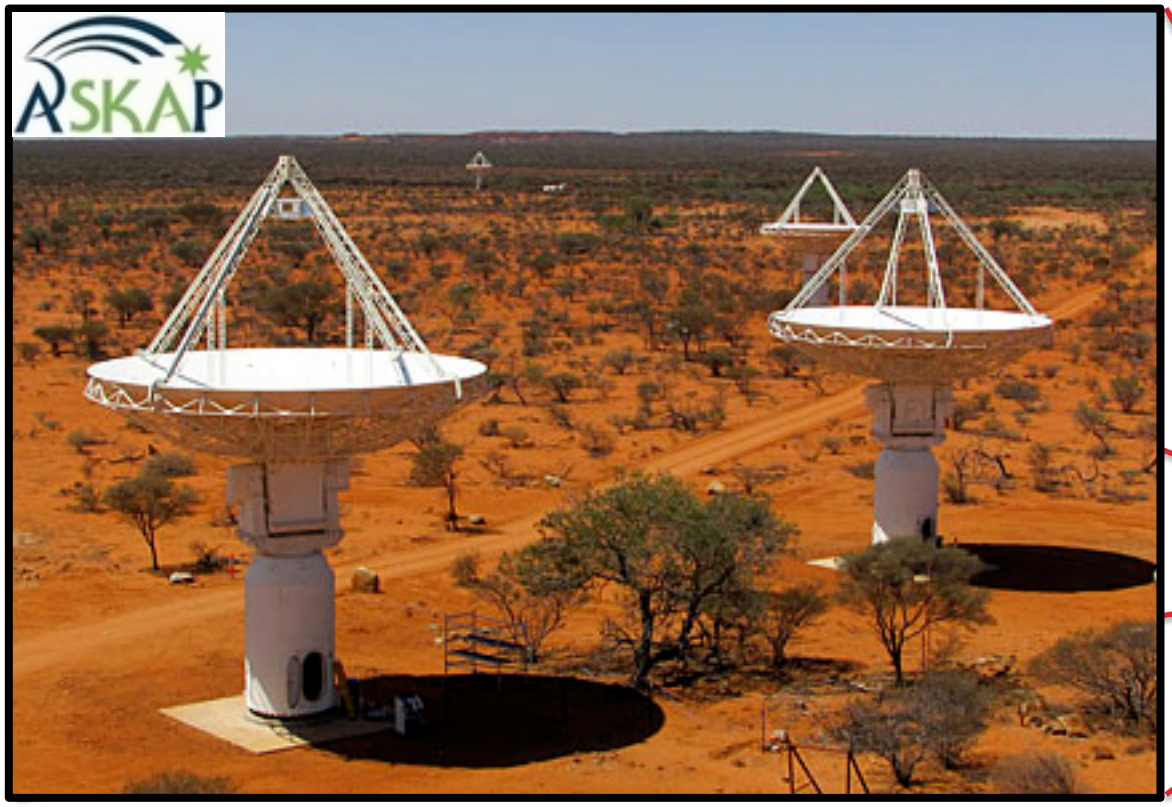
Australian SKA Pathfinder (ASKAP)



- 36 antennas
- 700-1800MHz
- 30deg^2 FoV via PAF
- Science operations begin early 2015
- VAST images every 5s

www.atnf.csiro.au/projects/askap/ - Terrace Photographers

maps.google.com.au

The VAST survey

› A survey with the Australian Square Kilometer Array Pathfinder (ASKAP)

		VAST-Deep			
	VAST-Wide	Multi-field	Single Field	VAST-Galactic	Commensal
Observing time (h)	4 380	3 200	400	600	1.5 years
Survey area (deg^2)	10 000	10 000	30	750	10 000
Time per field	40 s	1 h	1 h	16 min	12 h
Repeat	Daily	7 times	Daily	64 times	None
Observing freq (MHz)	1 130–1 430				
Bandwidth (MHz)	300				
RMS sensitivity (mJy beam^{-1})	0.5	0.05		0.1	0.01
Field of view (deg^2)	30				
Angular resolution	10 arcsec				
Spectral resolution	10 MHz				
Time resolution	5 s				
Polarisation products	*IQUV*				

What we are looking for

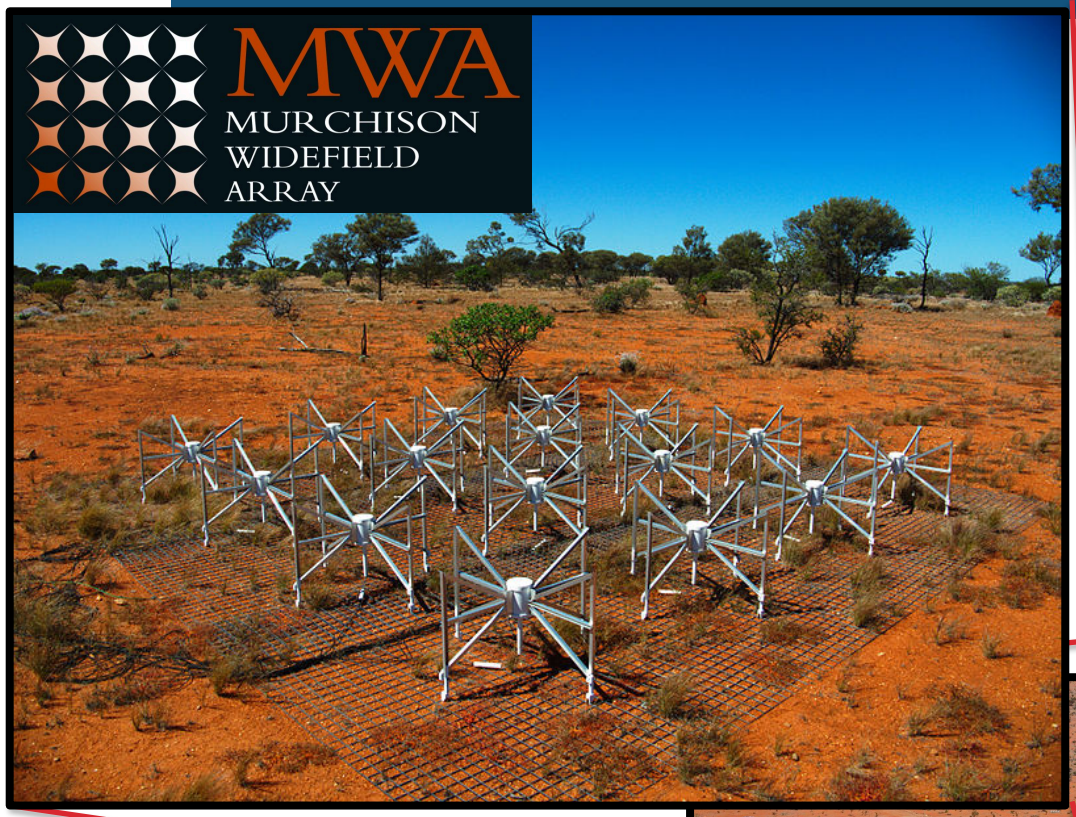
- Explosions
  - Gamma-ray bursts
  - Supernovae
- Propagation Effects
  - Interstellar Scintillation
  - Extreme Scattering Events
  - Gravitational Lensing
- Accretion and Magnetism
  - AGN variability
  - Tidal Disruption Events
  - Flares from
    - Black Holes, Neutron Stars
    - micro quasars
  - Novae, Flare Stars, Active Stars
- The Unknown
  - Eg “The Burper”

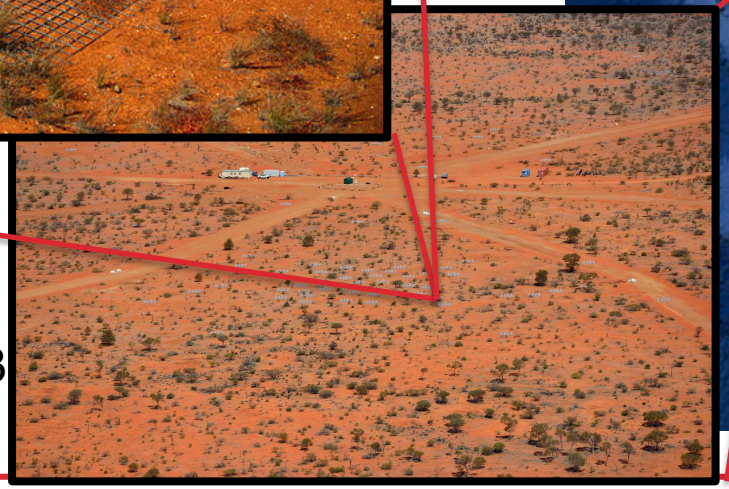
ASKAP-VAST data products

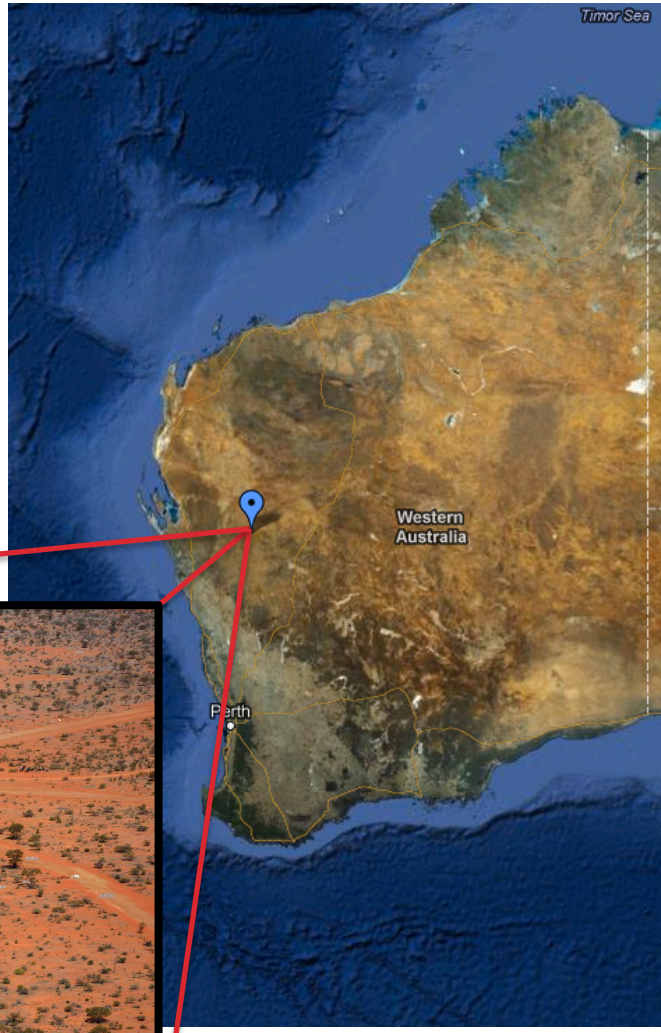
- Transient Alerts
  - ~ seconds: Location and quality only, fast follow up requests
  - ~ minutes: + probable classification, light curve, (archival) multi-wavelength info
  - Ongoing: light curve, classification probability, follow up results, predictions

- Survey data
  - ~ hour-day: Light curves + classification for all sources
    - Hours for VAST team
    - Days for public after QC
  - ~ months: Science quality catalogs, links to related observations, image data

MWA

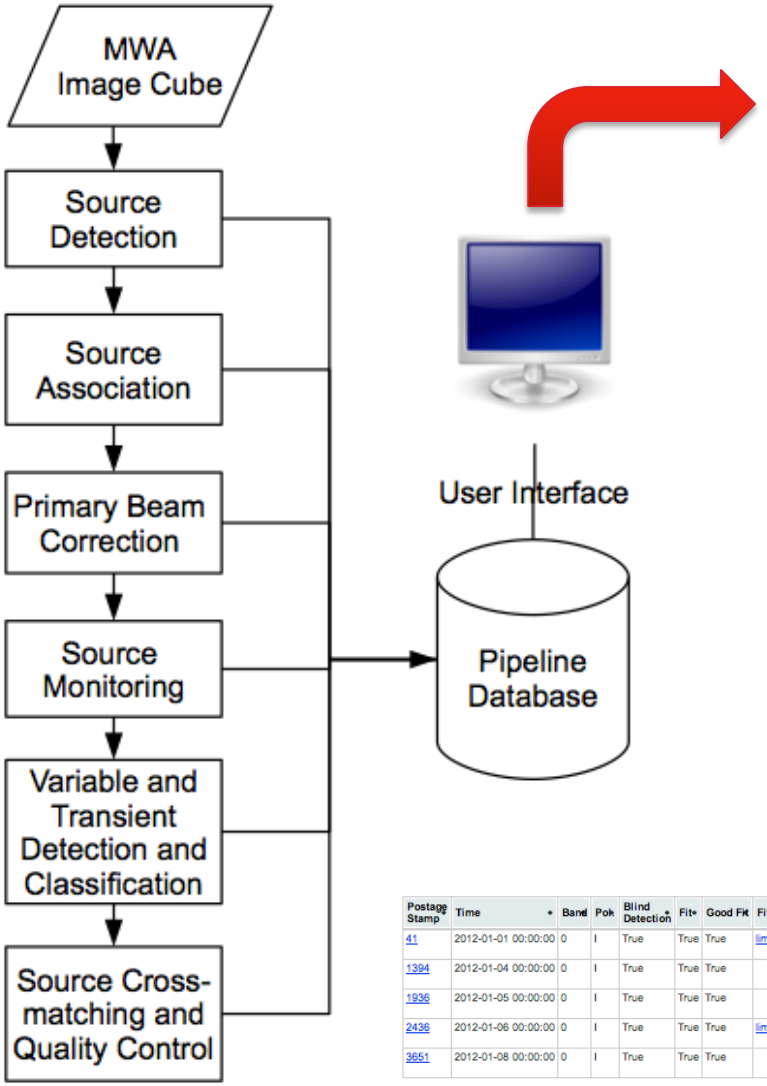


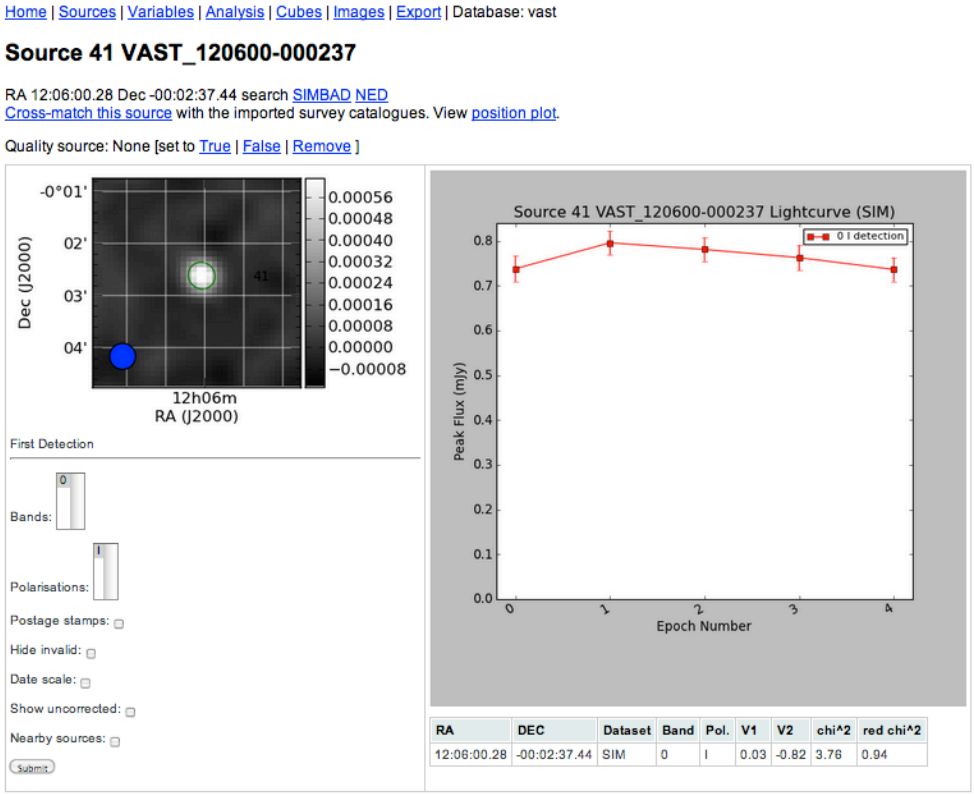




- 128 Tiles
- 80-300MHz
- 615deg^2 FoV
- Observing begins July 2013
- Continuum images - 2m

Data Products





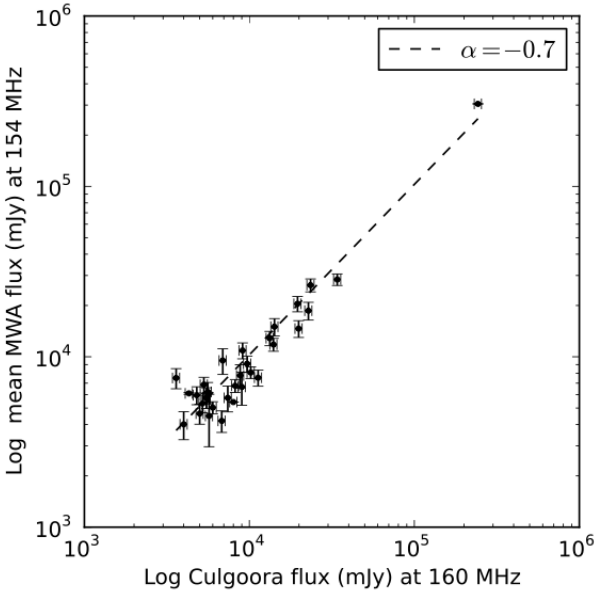
Flux Measurements (5)

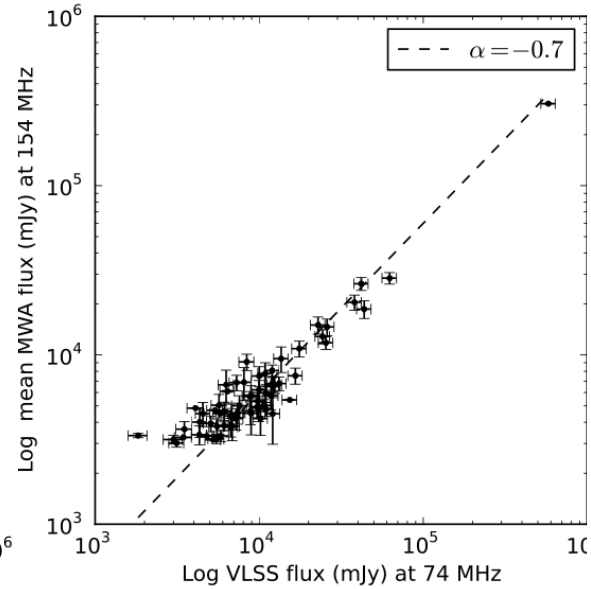
Postage Stamp	Time	Band	Pol	Blind Detection	Fit	Good Fit	Fit Flags	Valid	Total Flux (mJy)	Err Total Flux (mJy)	Peak Flux (mJy)	Err Peak Flux (mJy)	Peak Pixel (mJy)	RMS (mJy)	SNR	PB Corr	Image	RA	Dec	bmaj (sec)	bmin (sec)	PA (deg)	Probability
41	2012-01-01 00:00:00	0	I	True	True	True	limit fix(1)	True (0)	0.78	0.04	0.74	0.03	0.72	0.03	27.3	1.00	1	12:06:00.24 ± 0.187" (181.501)	-00:02:37.12 ± 0.186" (-0.044)	31.743 ± 0.503	30.000 ± -3600.000	-312 ± 11	100.00
1394	2012-01-04 00:00:00	0	I	True	True	True		True (0)	0.86	0.03	0.80	0.03	0.79	0.02	32.0	1.00	4	12:06:00.30 ± 0.150" (181.501)	-00:02:37.94 ± 0.159" (-0.044)	32.321 ± 0.400	30.132 ± 0.393	0 ± 7	99.56
1936	2012-01-05 00:00:00	0	I	True	True	True		True (0)	0.82	0.03	0.78	0.03	0.78	0.02	31.5	1.00	5	12:06:00.31 ± 0.156" (181.501)	-00:02:37.45 ± 0.160" (-0.044)	30.972 ± 0.420	30.326 ± 0.400	17 ± 25	99.99
2436	2012-01-06 00:00:00	0	I	True	True	True	limit fix(1)	True (0)	0.78	0.04	0.76	0.03	0.76	0.03	28.8	1.00	6	12:06:00.30 ± 0.177" (181.501)	-00:02:37.10 ± 0.173" (-0.044)	30.612 ± 0.472	30.000 ± -3600.000	90 ± 30	100.00
3651	2012-01-08 00:00:00	0	I	True	True	True		True (0)	0.79	0.03	0.74	0.03	0.72	0.02	29.6	1.00	8	12:06:00.25 ± 0.169" (181.501)	-00:02:37.58 ± 0.168" (-0.044)	31.423 ± 0.441	30.750 ± 0.437	54 ± 26	99.99

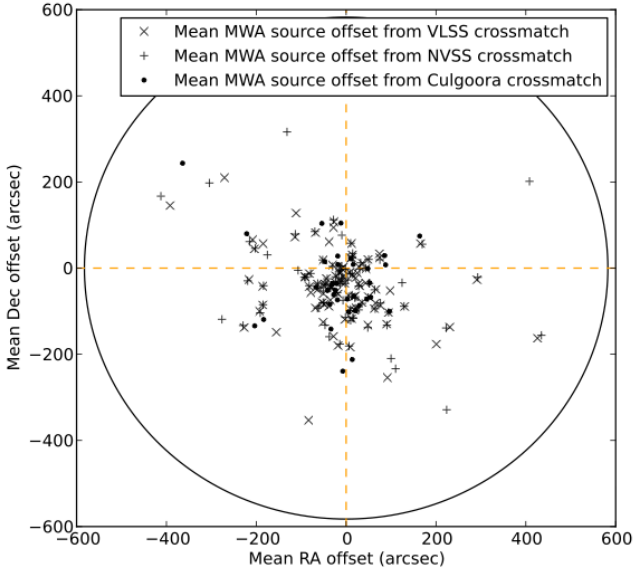
Data Products

- Per Measurement
  - RA, Dec, a, b, θ, [+ errors], Fit type, quality of fit
  - PB correction, local rms
  - blind detection?
- Per Image (Cube)
  - Source count [detect + measure]
  - Phase center, usable area, zenith distance, hour angle, integration time
  - Frequency, polarization
- Per Source
  - All measurements
  - Average SNR
  - Variability [degree x3, significance x1]
  - Association with external catalogs

Current Data Use - Analysis







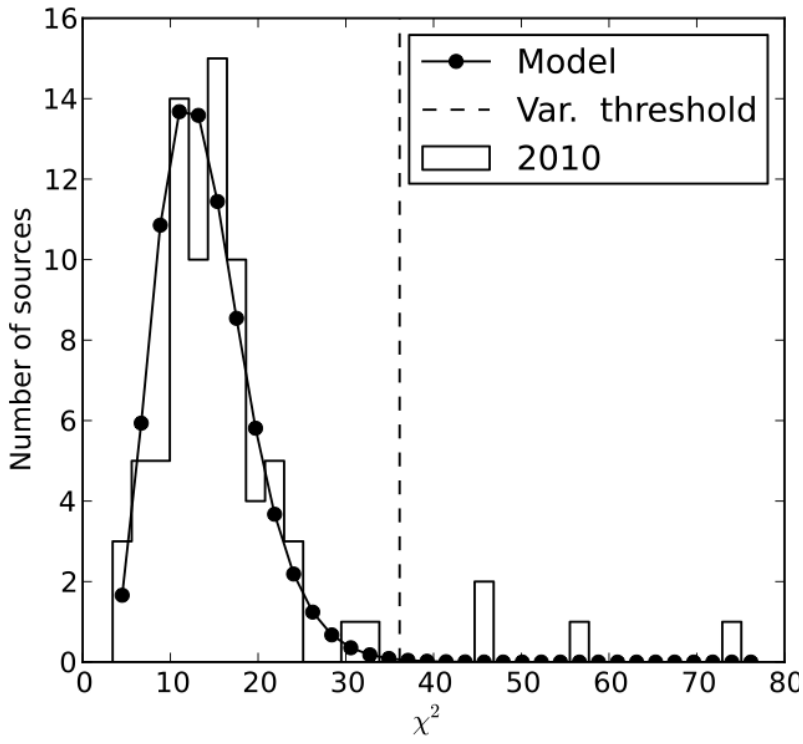
› Calibration verification

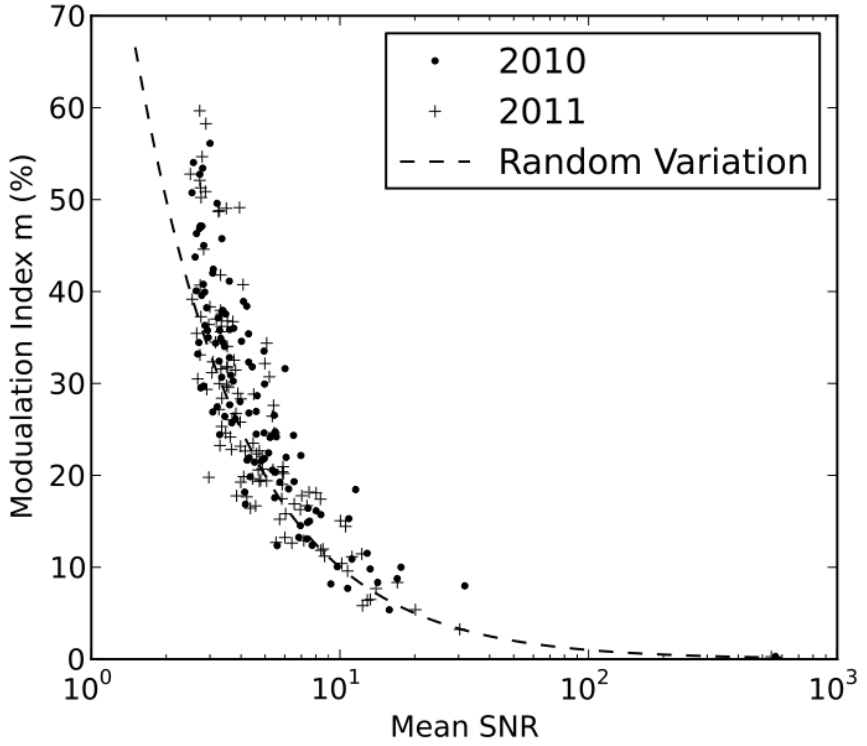
- Flux/Astrometry confirmation via external catalogs

Bell et al, 2013, in prep.

Current Data Use - Visualization

› (Interesting Variable Sources) Show me sources which have a variability that is at least 99% significant, and a variability index that is greater than 10%.





Bell et al, 2013, in prep.

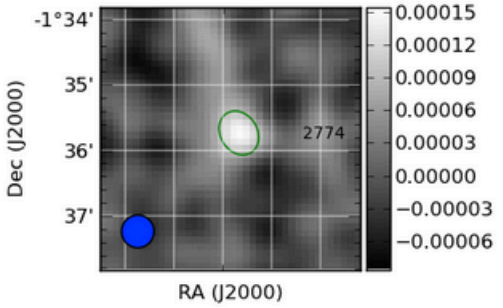
Current Data Use - Discovery

- (Transient Sources) Show me sources that are detected in only 1 epoch, with measurements in at least 3 epochs.

Source 1636 VAST_115635-013543

RA 11:56:35.01 Dec -01:35:43.94 search SIMBAD NED
Cross-match this source with the imported survey catalogues. View position plot.

Quality source: None [set to True | False | Remove]



First Detection

Bands: 0

Polarisations: I

Postage stamps:

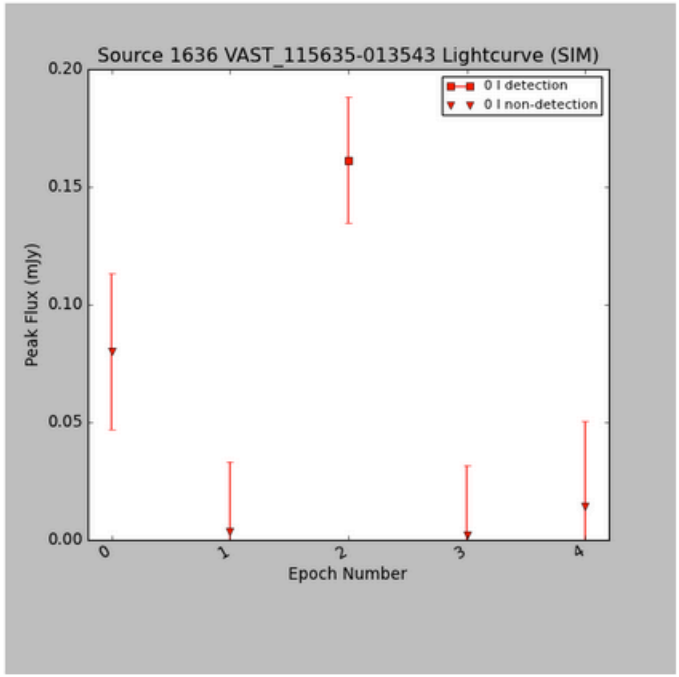
Hide invalid:

Date scale:

Show uncorrected:

Nearby sources:

Submit



RA	DEC	Dataset	Band	Pol.	V1	V2	chi^2	red chi^2
11:56:35.01	-01:35:43.94	SIM	0	I	1.32	45.53	23.79	5.95

Flux Measurements (5)

Is the VO (currently) enough?

- Publishing
  - Alerts (VOEvent)
  - TimeSeries
    - Flux vs time (SimpleTimeSeries)
    - Shape vs time
    - <anything> vs time
  - Image Cubes
- Retrieval
  - Link to follow up observations
  - Archival data
  - Real Time data (TimeSeries)
  - Spectral Information
  - Third party analysis (Annotation)

We want metadata on images and catalogs that includes information relevant to time domain astronomy. In particular we want **a catalog/service footprint** that will be useful for time domain astronomy.

Barriers to Success

- A systematic way to **access** radio images
  - Format is largely irrelevant so long as our VOTools can read it
- Calibrated Radio image archive similar to what is available at other wavelengths
  - Maybe even multiple versions of the same image with different processing options
- (Radio image) archives for more than just surveys
  - Even ToOs should have a calibrated data set in the archive
- Java vs Python

Summary

- The VAST project will benefit greatly from VO tools, data models, and transport.
- The VO can support our current workflow
  - Our future needs are not currently met but many of them are identified in development plans
- We would benefit from
  - Catalog/Repository footprints that are Time Domain friendly
  - Archives of calibrated radio images beyond large surveys