CHILES VERDES

A deep radio transient survey

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Contents

CHILES : COSMOS HI Large Extragalactic Survey

- L – Band survey centered at the COSMOS field

- HI properties as function of redshift (0<z<0.45), galaxy mass, color and location in the large scale structure

- Full-polarization continuum radio survey
- Nature of intergalactic magnetic fields and their potential origins in the early Universe

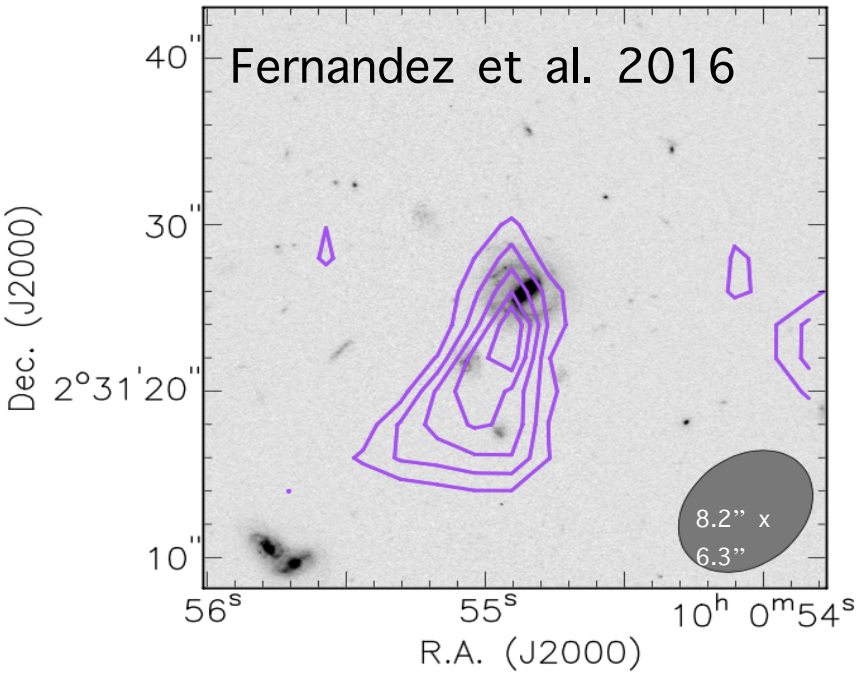
CHILES

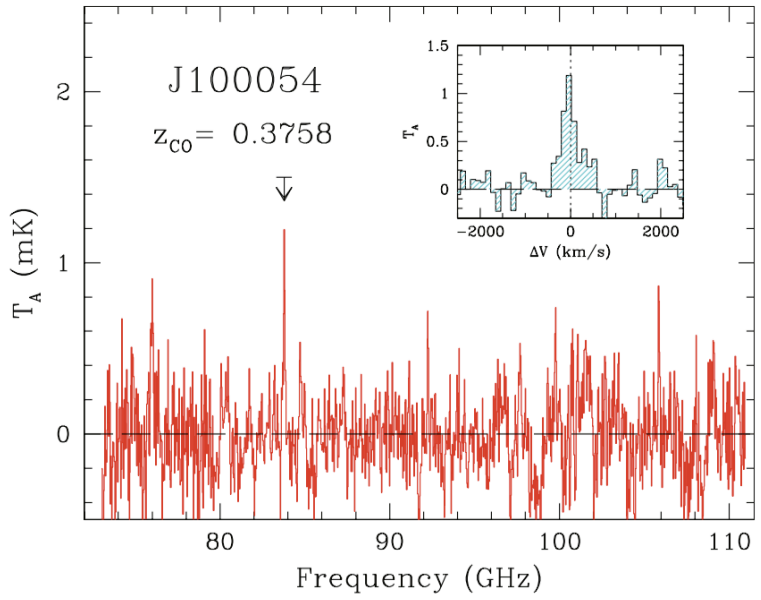
VERDES : Variable & Explosive Radio Dynamic Evolution Survey

Deep survey for transient and variable objects in the radio sky, searching for explosions, collisions, and disruptions

Radio Observations

- VLA, B- configuration
- ~1000 hours (2013-2016)
- One pointing, 0.5 deg in diameter (0.25 sq.deg in area)
- 4 sub bands, 64 channels, 128MHz bandwidth each
- Full polarization over 512MHz
- Image rms noise ~ 0.5μJy/beam(continuum) --50μJy/beam/channel(spectral line)
- 5” resolution --- 13 km/s velocity resolution



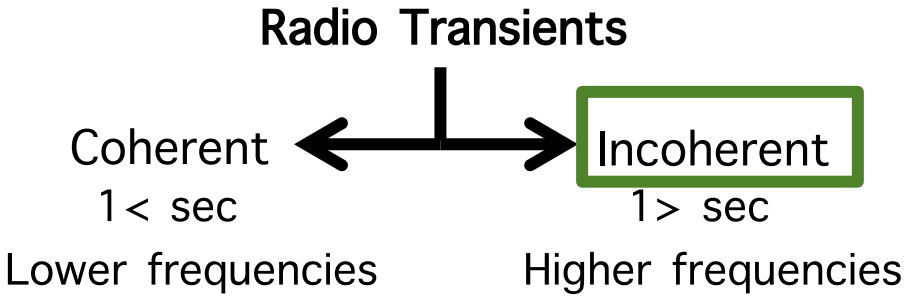


- Highest z image of HI in emission (178h)
- Star-bursting galaxy at z= 0.376
- Gas rich system (M_{HI}= 2.9x$10^{10}M_{\odot}$)

For the detailed study of the gas content, see Fernadez et al 2016 , arXiV: 1606.00013

CHILES VERDES : Variable & Explosive Radio Dynamic Evolution Survey

- Explosive events and relativistic jets • Non-thermal emission • High magnetic field



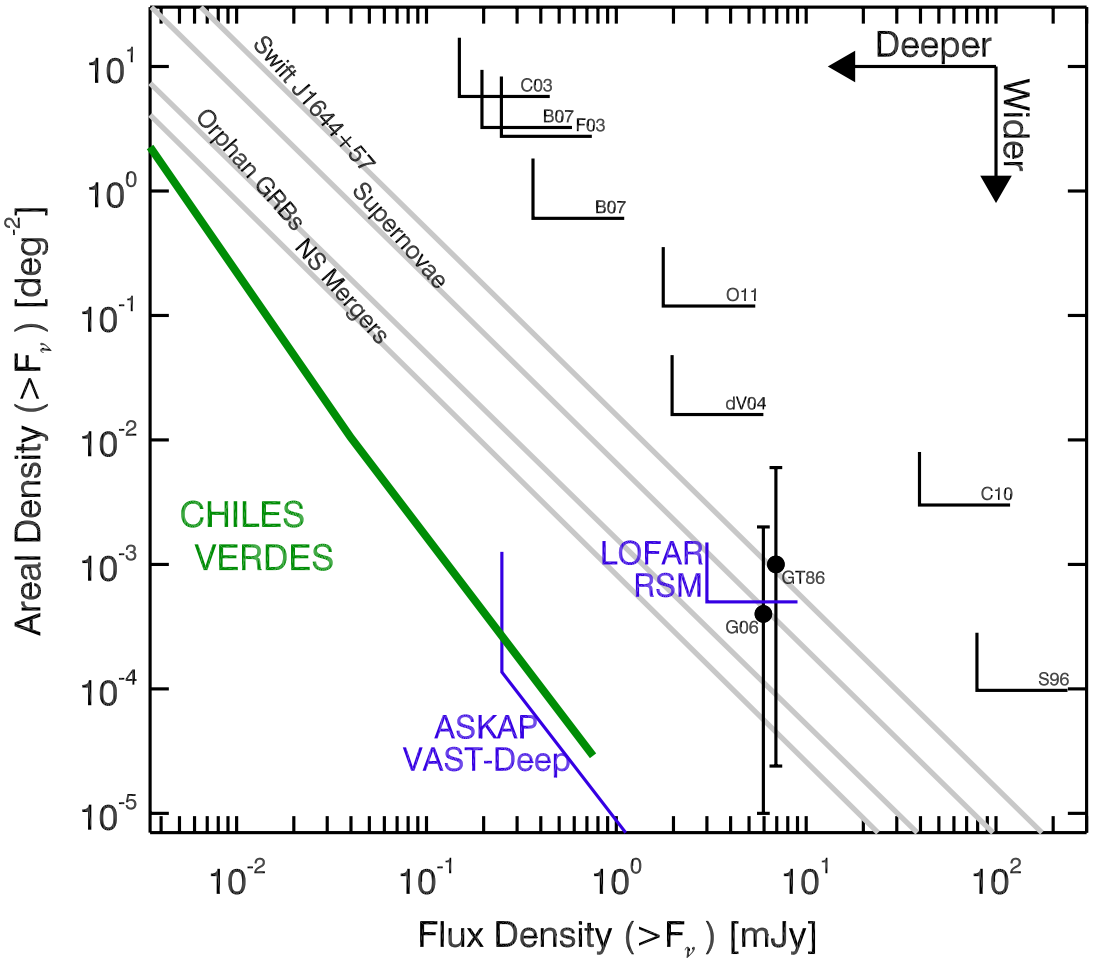
Slow Transients
Type II SN
NS –NS Mergers
NS- BH Mergers
GRB Orphan Afterglows
Tidal Disruption Events
"Mystery" Transients

Parameter Space of radio transient surveys

$$A_{\text{cumulative}} = A_{\text{epoch}} * (N_{\text{epoch}} - 1)$$

$$N \propto F_{\nu}^{-3/2}$$

Frail et al. 2012



CHILES VERDES:

~1000 hours

- Narrower areal density

BUT

- Deeper (2 orders of magnitude)

✓ Multi- wavelength COSMOS data

(deep optical imaging for identifying transient hosts)

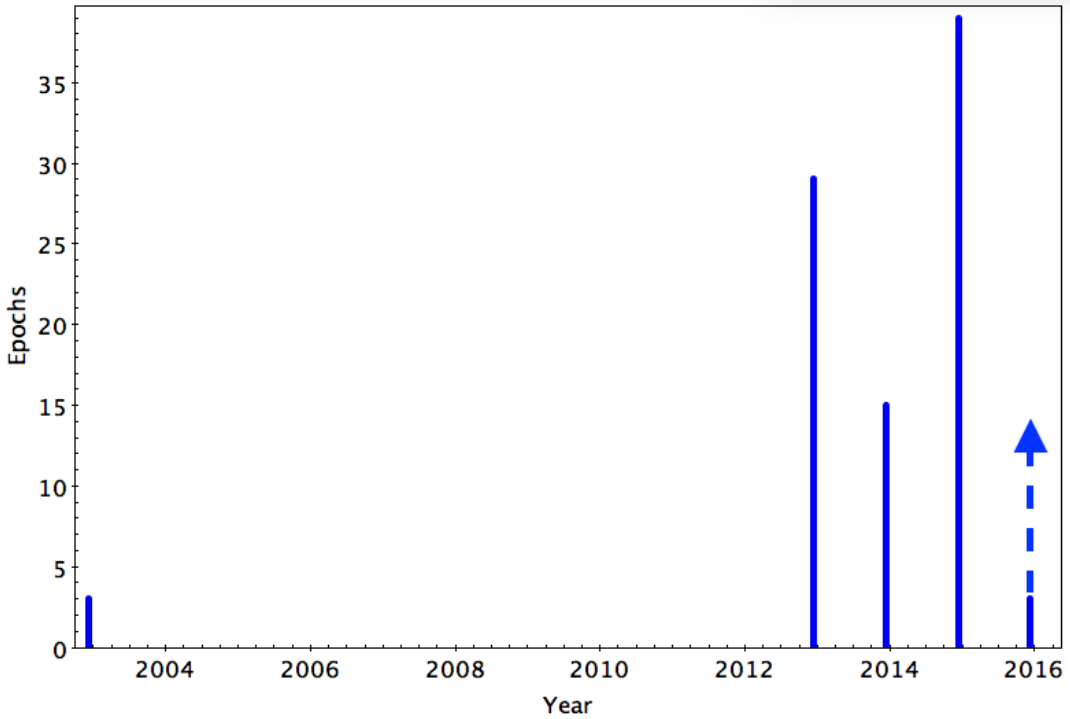
✓ Optical : 2m Liverpool telescope data in r band

30 epochs were performed on the same day as a radio observation

145 epochs in total!

✓ Radio : ~ 400 hours VLA data (2013/01~2016...)

✚ Old VLA data



Hunting for Transients in Image-Plane

Observation performed

Data fetched and processed

Calibrated Data and Image (no selfcal)

Data made available

All performed by Chris Hales

Automatic email sent

Oxford 'Pi' Cluster

four π sky

Data downloaded and sorted

TraP launched with new data

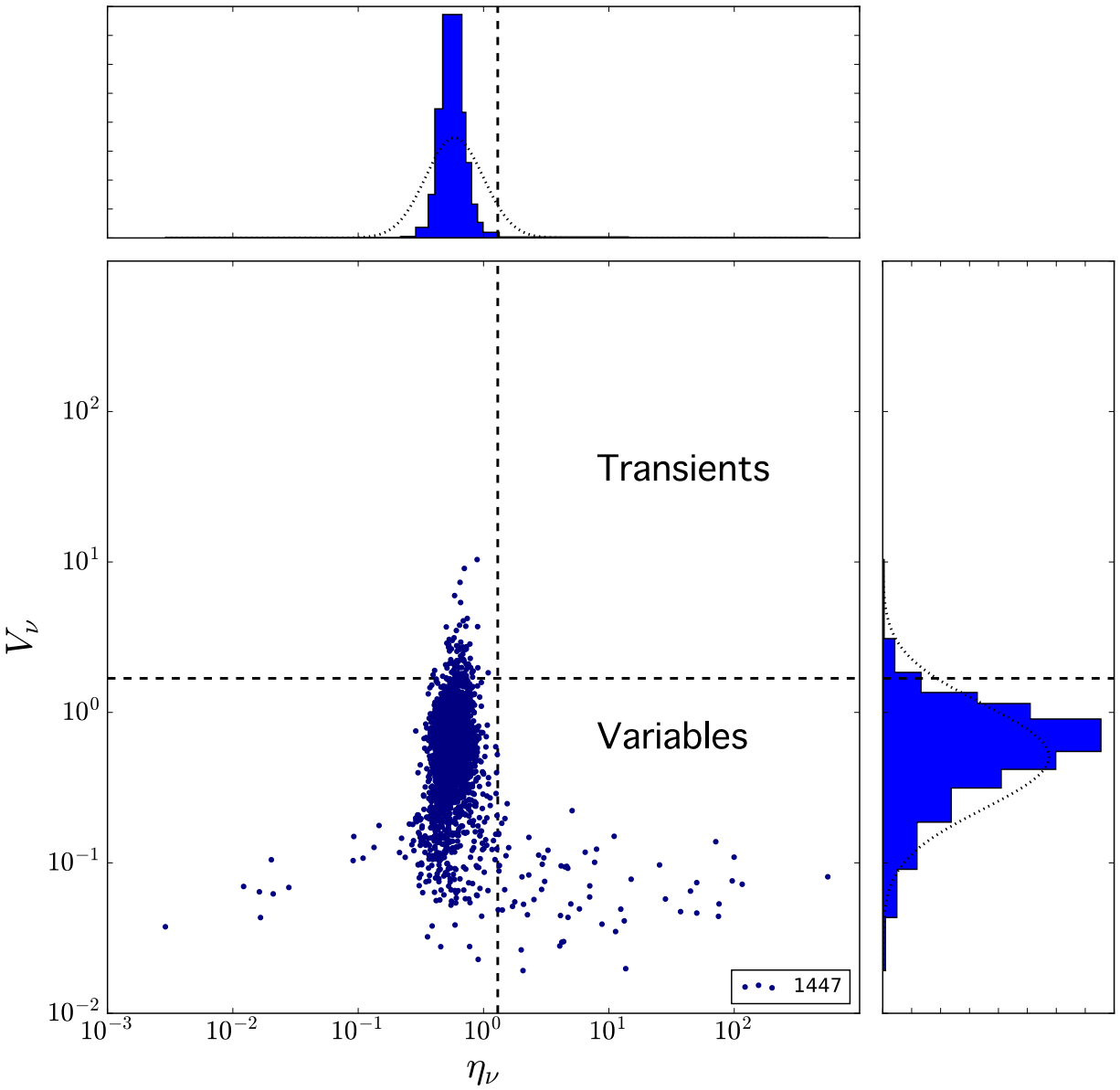
TraP results analysed

Email sent to user with results

All performed by Adam Stewart

TraP: Swinbank et al. 2015

Diagnostics/Variability metrics



Coefficient variation:

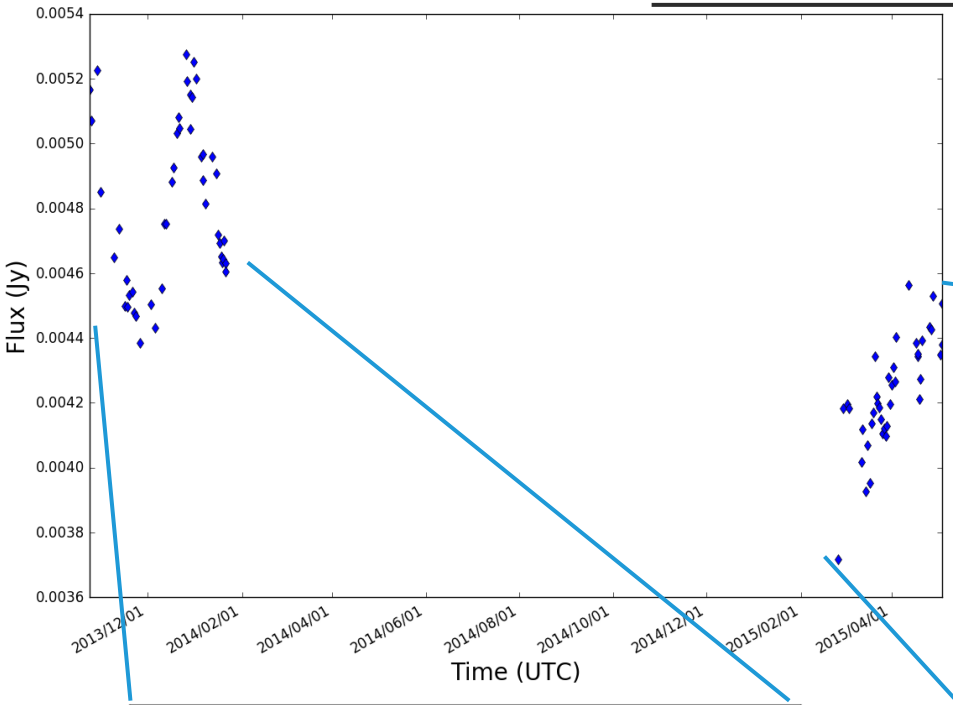
$$V_\nu \equiv \frac{s_\nu}{\overline{I_\nu}} = \frac{1}{\overline{I_\nu}}\sqrt{\frac{N}{N-1}(\overline{I_\nu^2} - \overline{I_\nu}^2)}$$

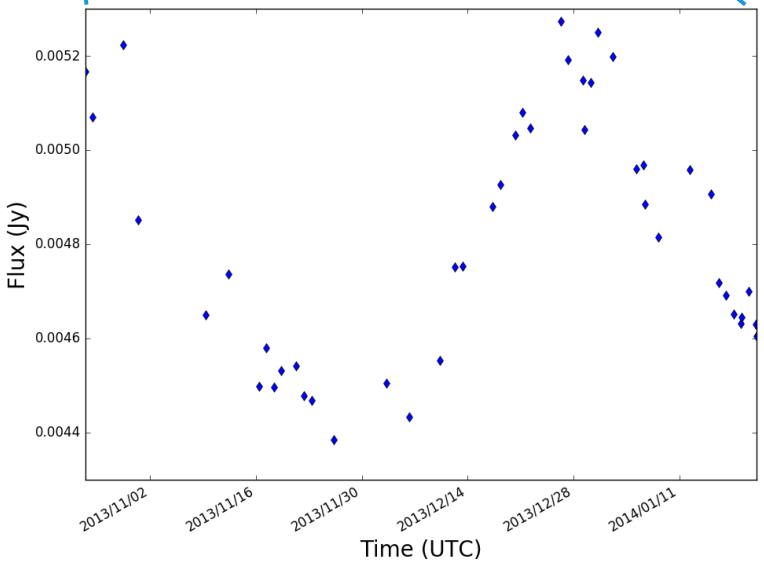
$$\eta_\nu \equiv \chi^2_{N-1} = \frac{1}{N-1}\sum_{i=1}^{N}\frac{(I_{\nu,i} - \overline{I_\nu}^*)^2}{\sigma^2_{I_{\nu,i}}}$$

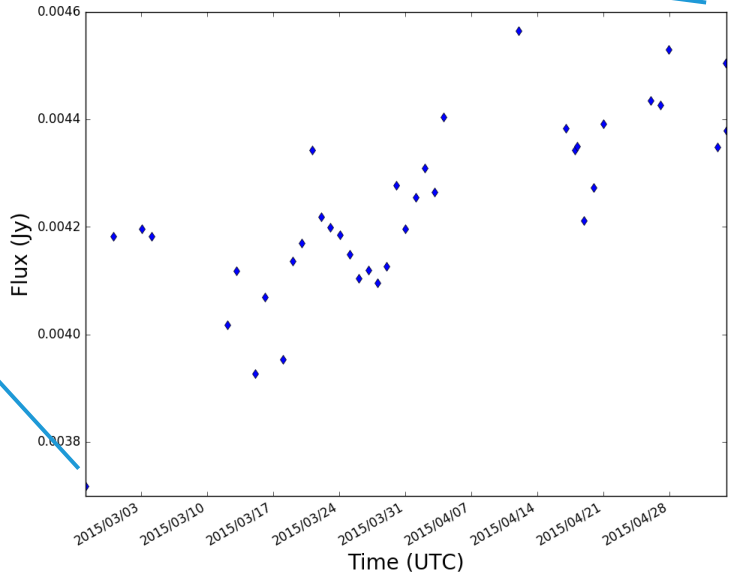
I_ν flux density at frequency, v, with uncertainty σ_ν.

S_ν standard deviation

Candidates (Variables)



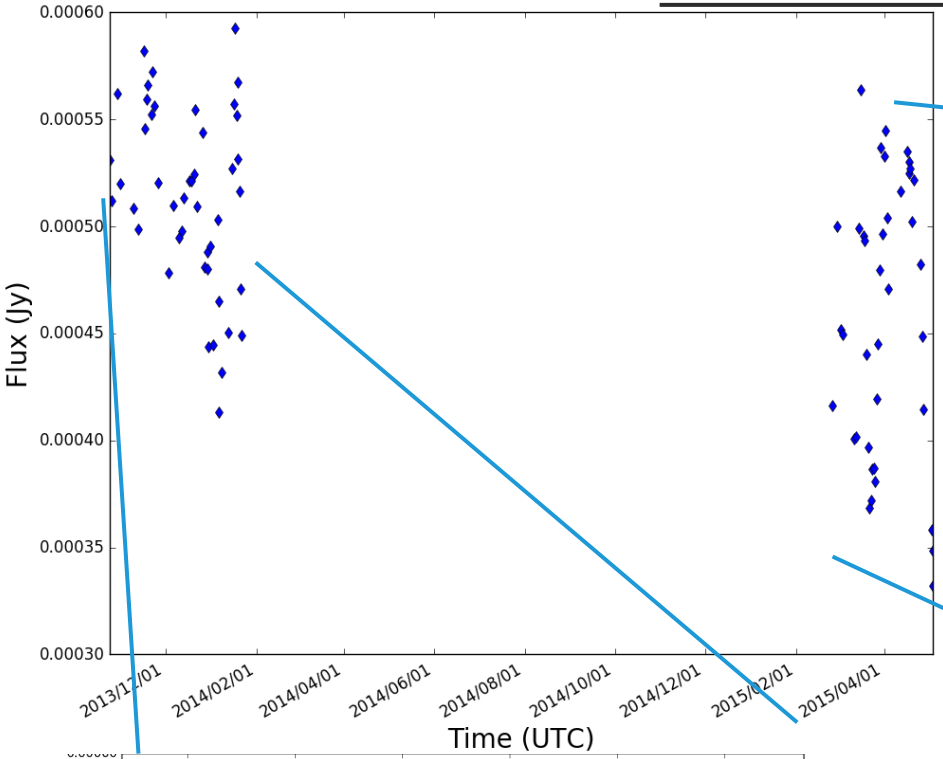


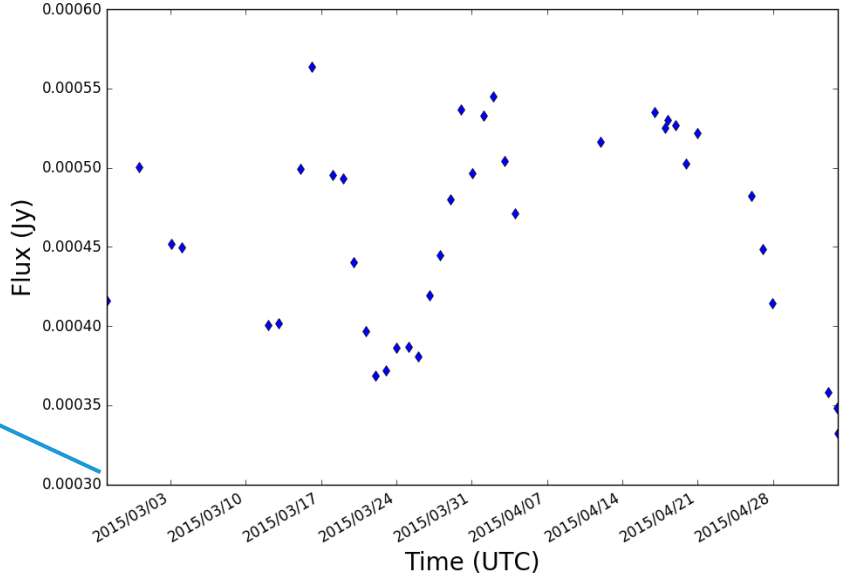


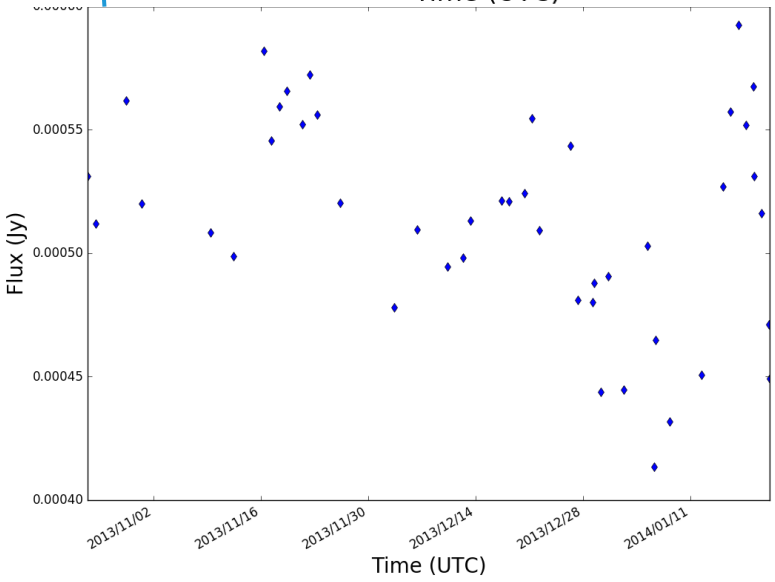
$V_\nu = 0.081$

$\eta_\nu = 557.623$

Candidates (Variables)



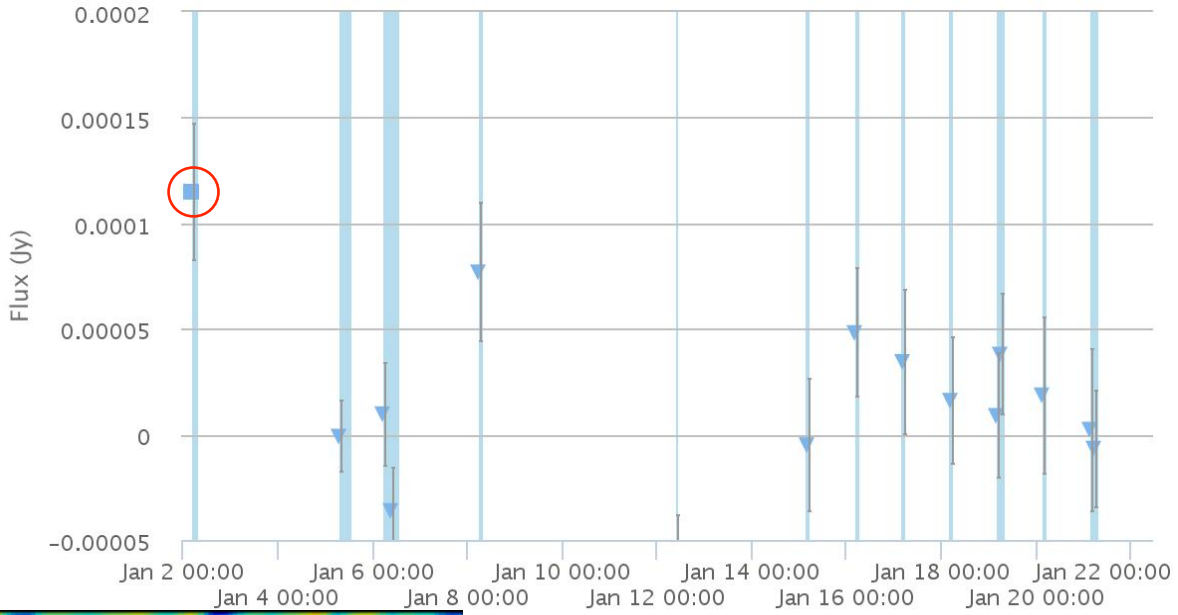


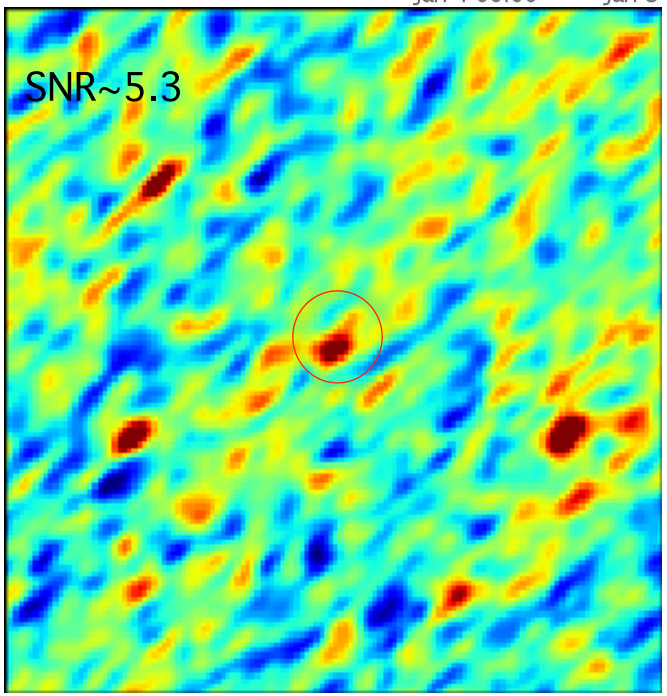


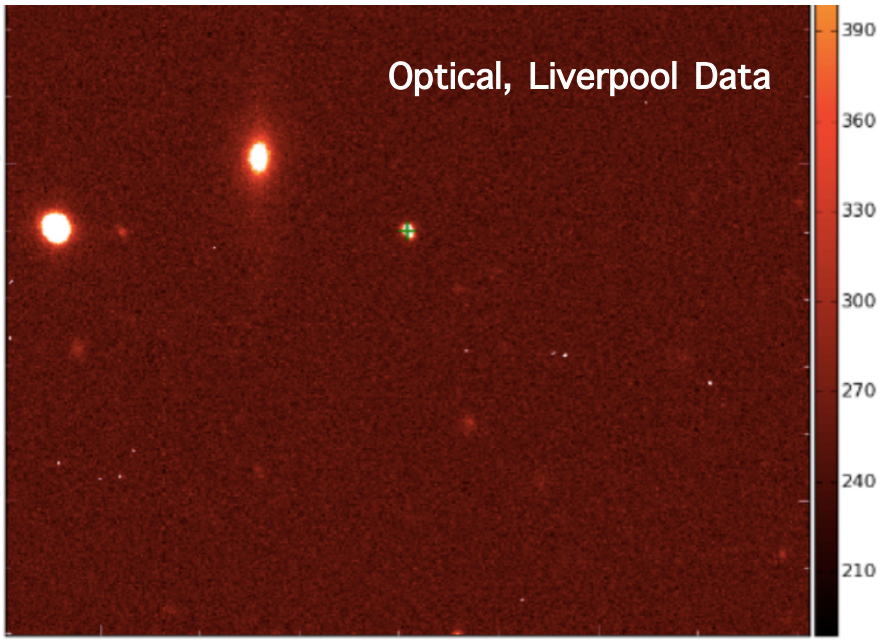
$$V_\nu = 0.123$$

$$\eta_\nu = 7.973$$

Candidates (Transients)







Ongoing…

- Analyzing the candidates (e.g: splitting in time, polarization, channels)
- Search on shorter timescales (~10 sec)
- More data are currently taken, B - configuration VLA May - October 2016
- Continuum data release ~ by the end of 2016 - Sources down to 10μJy will be catalogued at greater than 5 sigma

  - quiet radio sky at GHz frequencies
  - lack of strong variability

Mooley et al. 2016 (CNSS survey):

- slow radio transients < 1 / 10,000 persistent sources