TRANSIENT SEARCHES WITH MWA

UC Berkeley

with David Kaplan (UW-Milwaukee)
Steven Tingay, Tara Murphy, Martin Bell, Antonia Rowlinson, James Miller-Jones, and the MWA collaboration

BLIND TRANSIENT SEARCHES

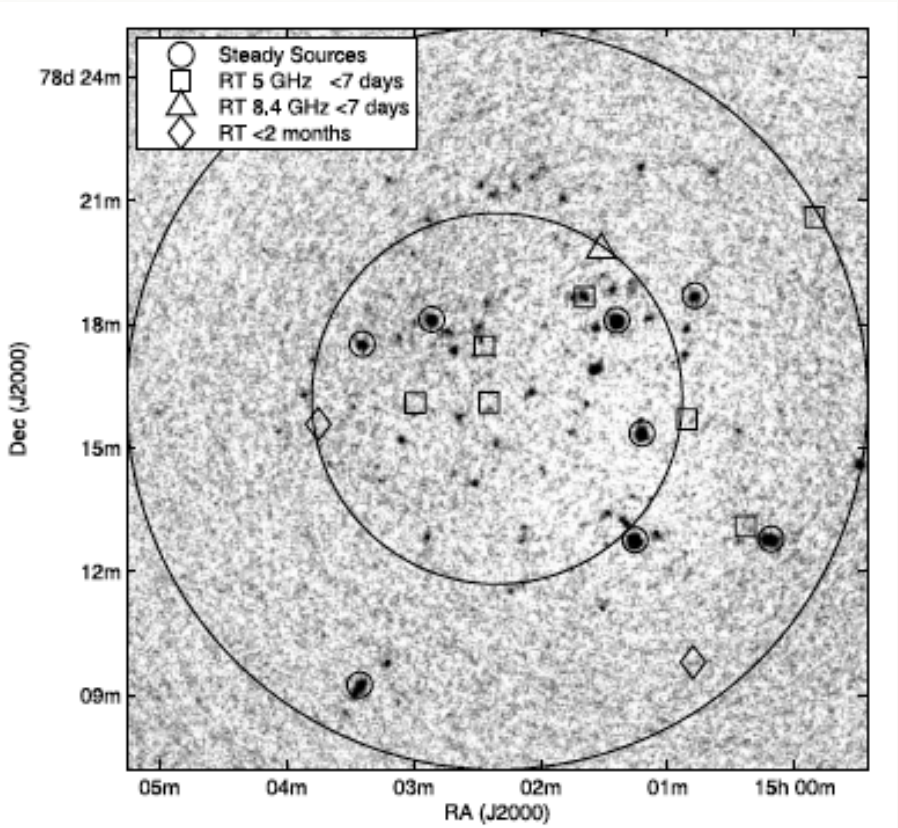
PI

Grad student

BLIND TRANSIENT SEARCHES

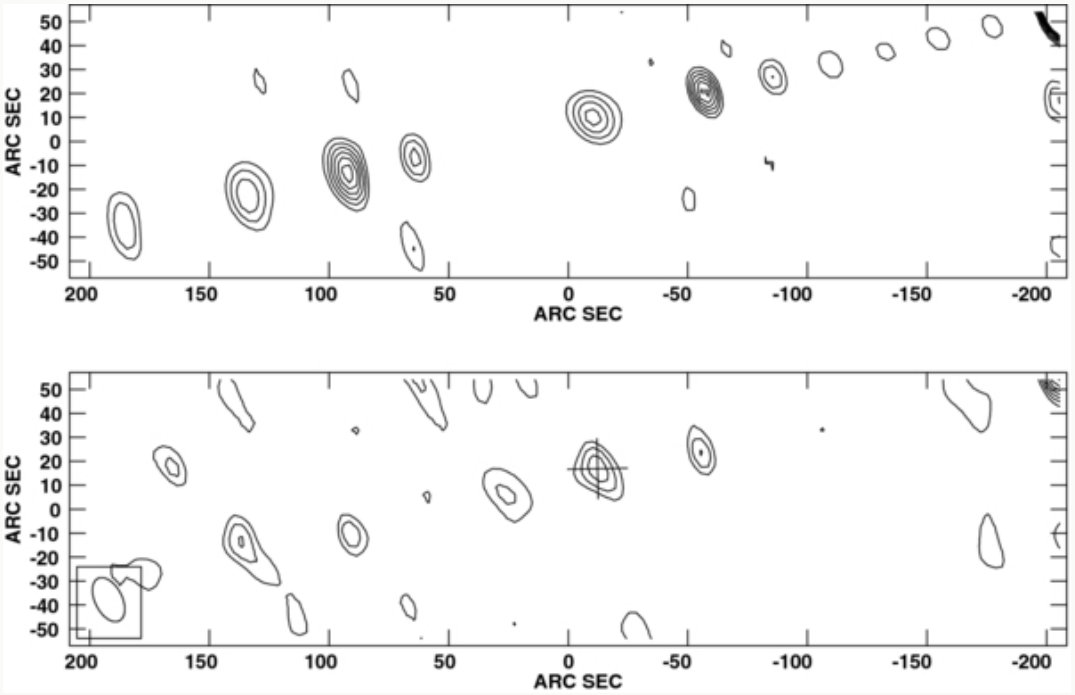
Bower et al. (2007) VLA archival observations at 5 and 8.4 GHz

944 epochs, 10 transient candidates



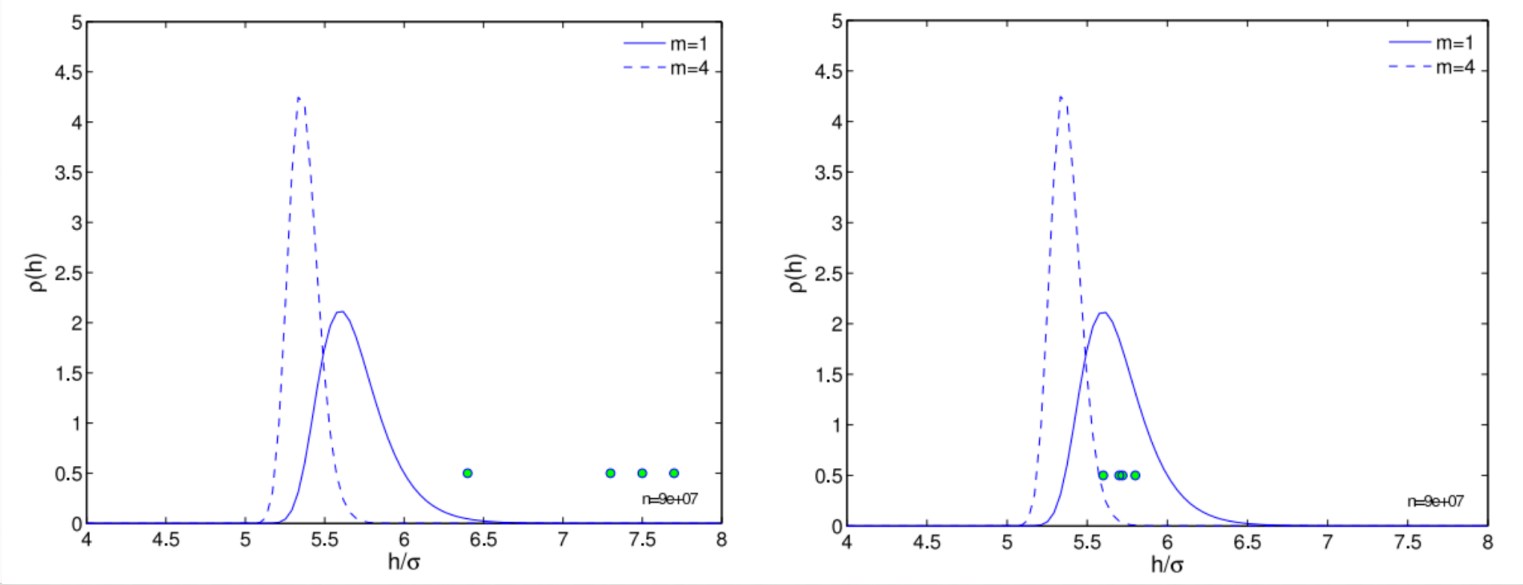
BLIND SEARCHES ARE HARD

Frail et al. (2012)
Probably only 1 is real
3 are marginal



RARE EVENTS HAPPEN OFTEN

Long tail, many trials
Non-Gaussian artifacts



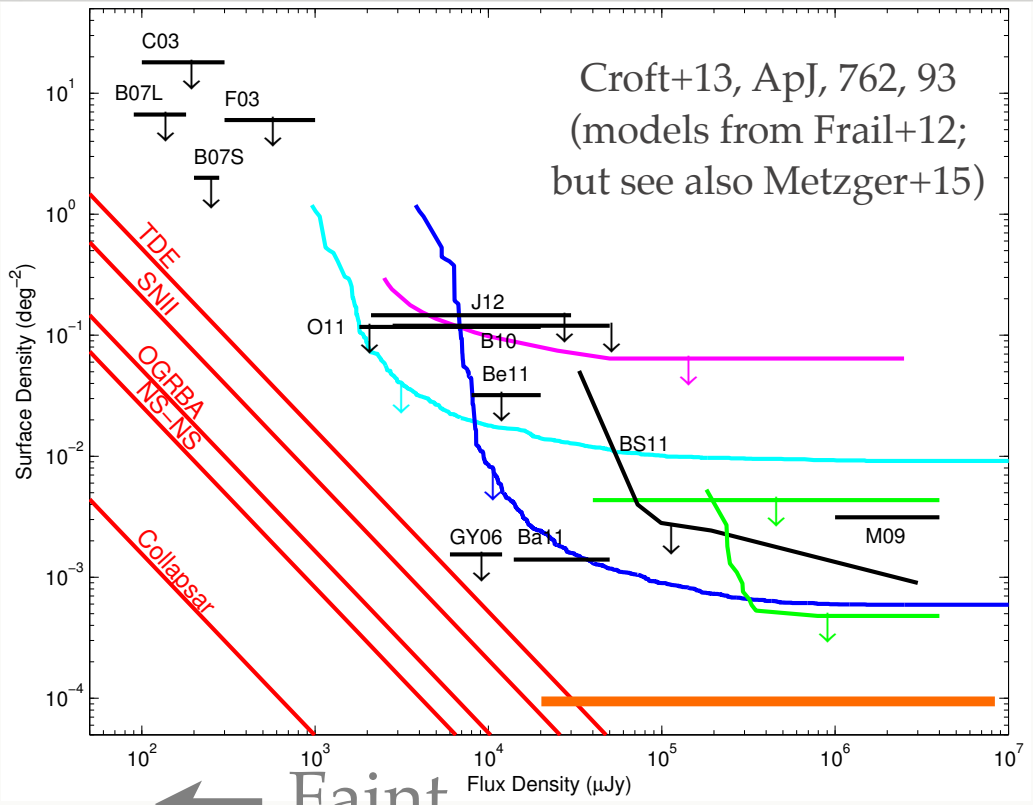
Frail et al. (2012)

at low thresholds and with large number of beams (cf §3) it would be prudent to set thresholds beyond mere statistical considerations[14]. A threshold of 9 or even 10σ may be appropriate. Alternatively, an immediate verification of a transient by deeper observation or a confirmation by observations at other wavelengths would allow detection of transients closer to threshold.

Frail et al. (2012)

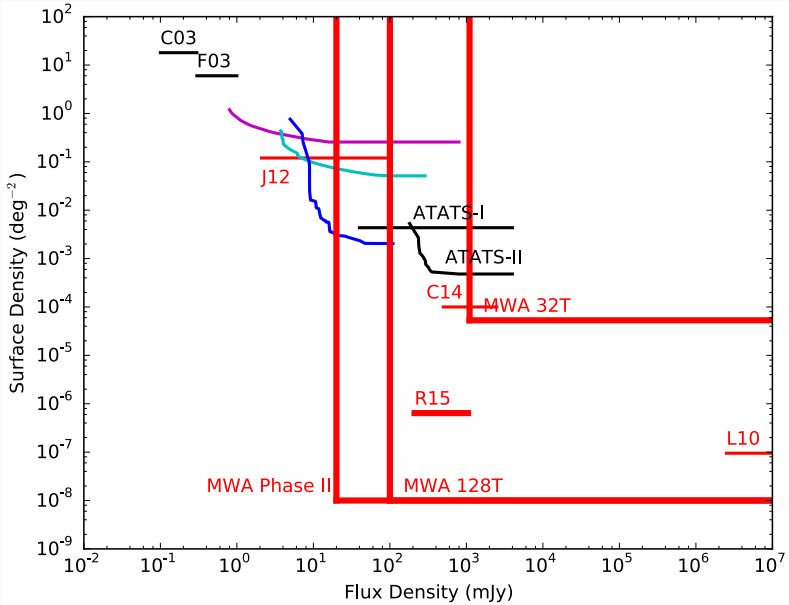
PUSHING SENSITIVITY AND AREA

Rare ↓

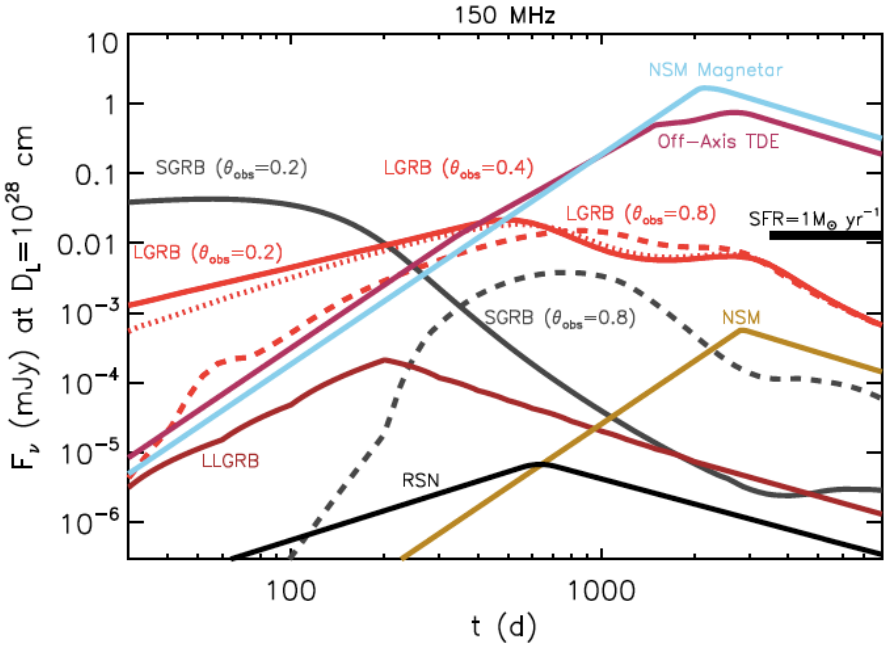


← Faint

MWA



MWA128T example 1000 h commensal survey



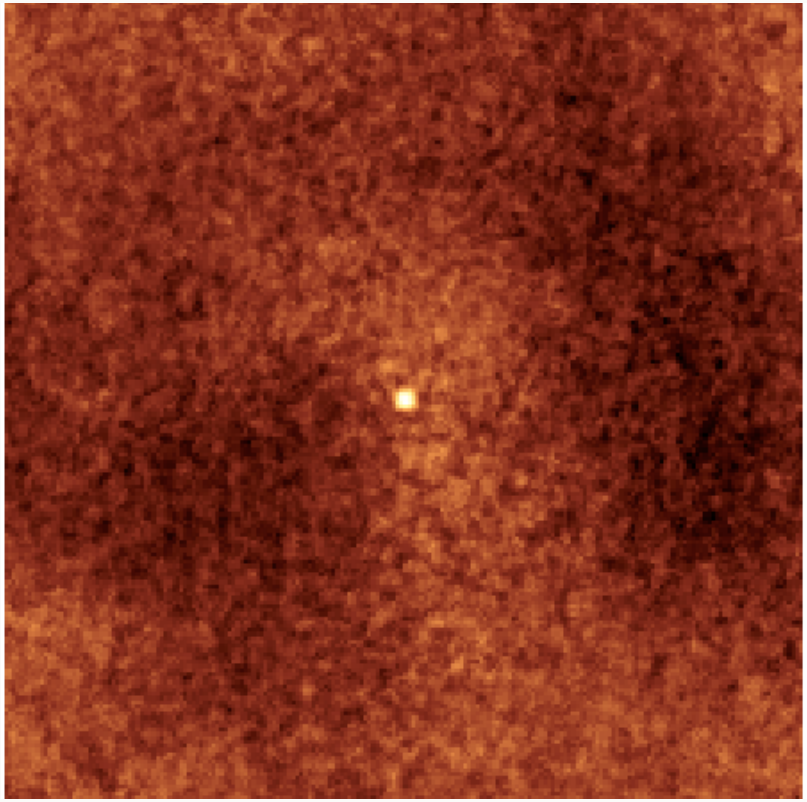
Metzger+15

HOW TO FIND THE GOOD STUFF

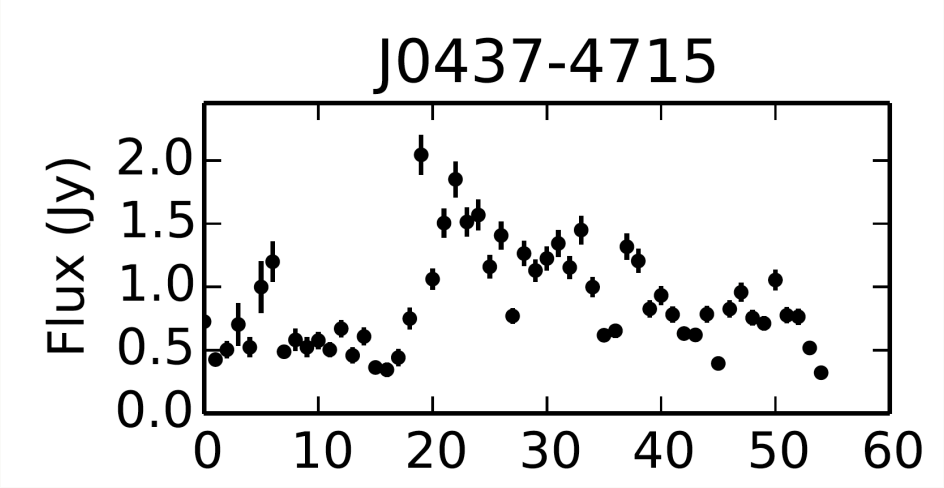
- Sources with known positions that may flare (e.g. pulsars, flare stars, blazars)
- Transients detected at other wavelengths (commensal / triggered) or with other methods (e.g. GRBs, GW and neutrino sources)
- Multi-epoch with cadence matched to sources of interest (e.g. TDEs), and conservative thresholds (10σ)

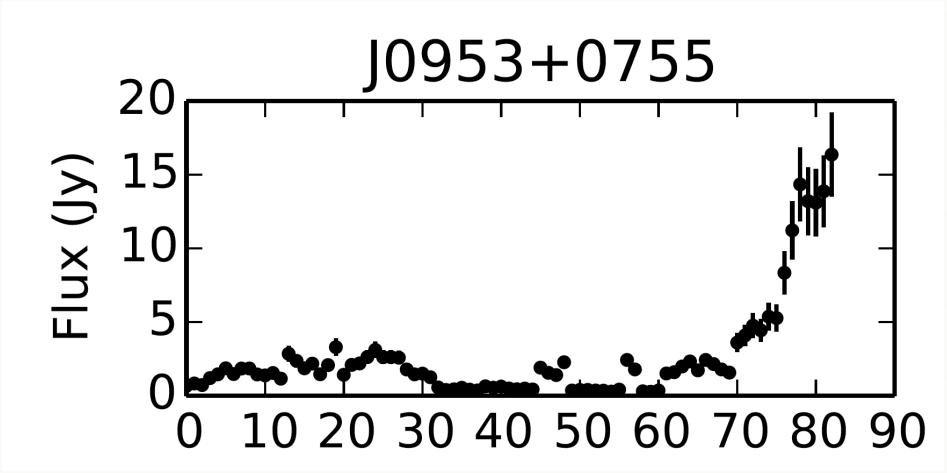
KNOWN SOURCES

Stack of 1700 pulsars, including 50 detections
20σ detection
Kaplan et al. in prep



MONITORING

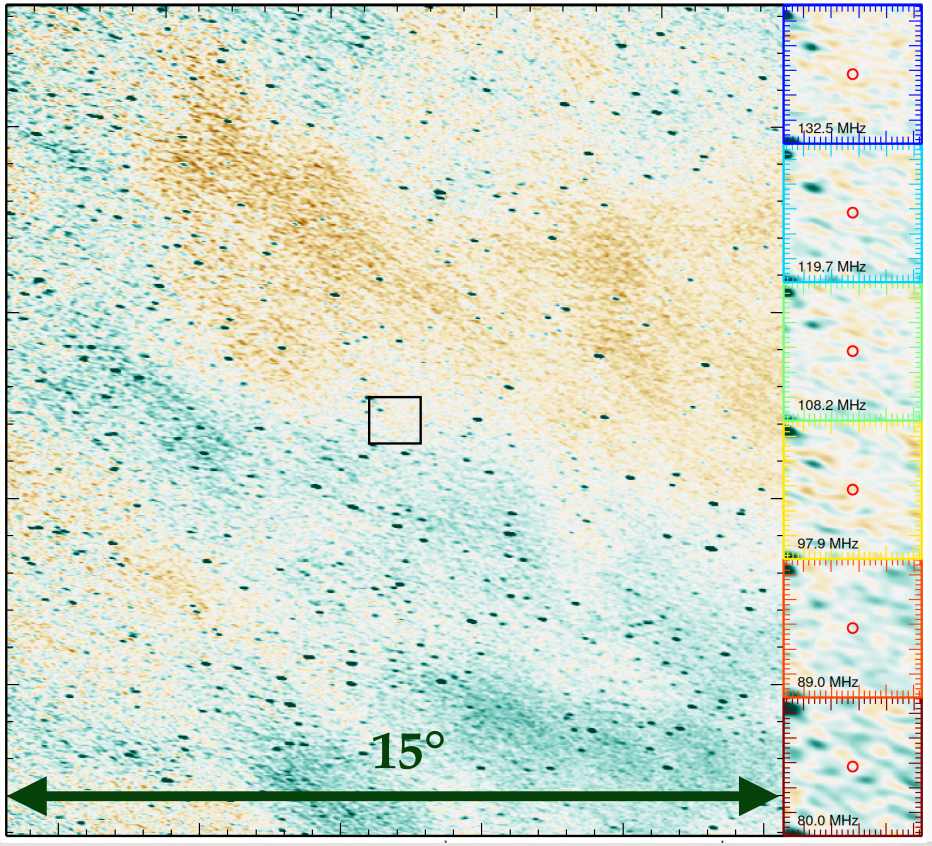




Bell et al. in prep

RAPID RESPONSE

Kaplan+15, ApJL, 814, 25
23 s - 30 min after SGRB
Fainter than 3 Jy on a timescale of 4 s
Can be used to provide constraints on GRB models



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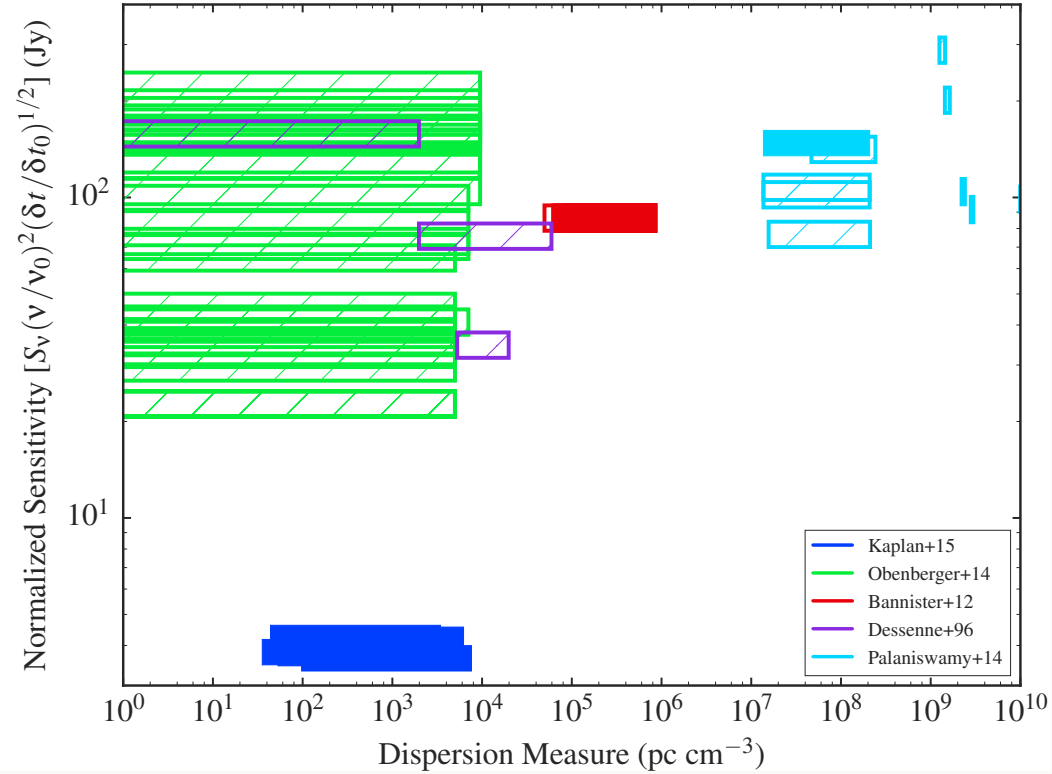
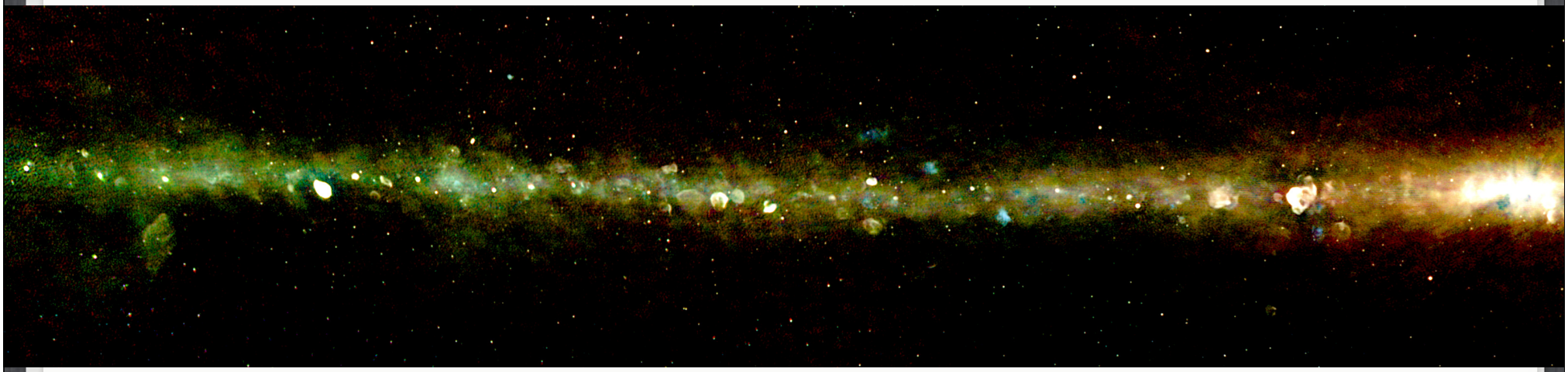


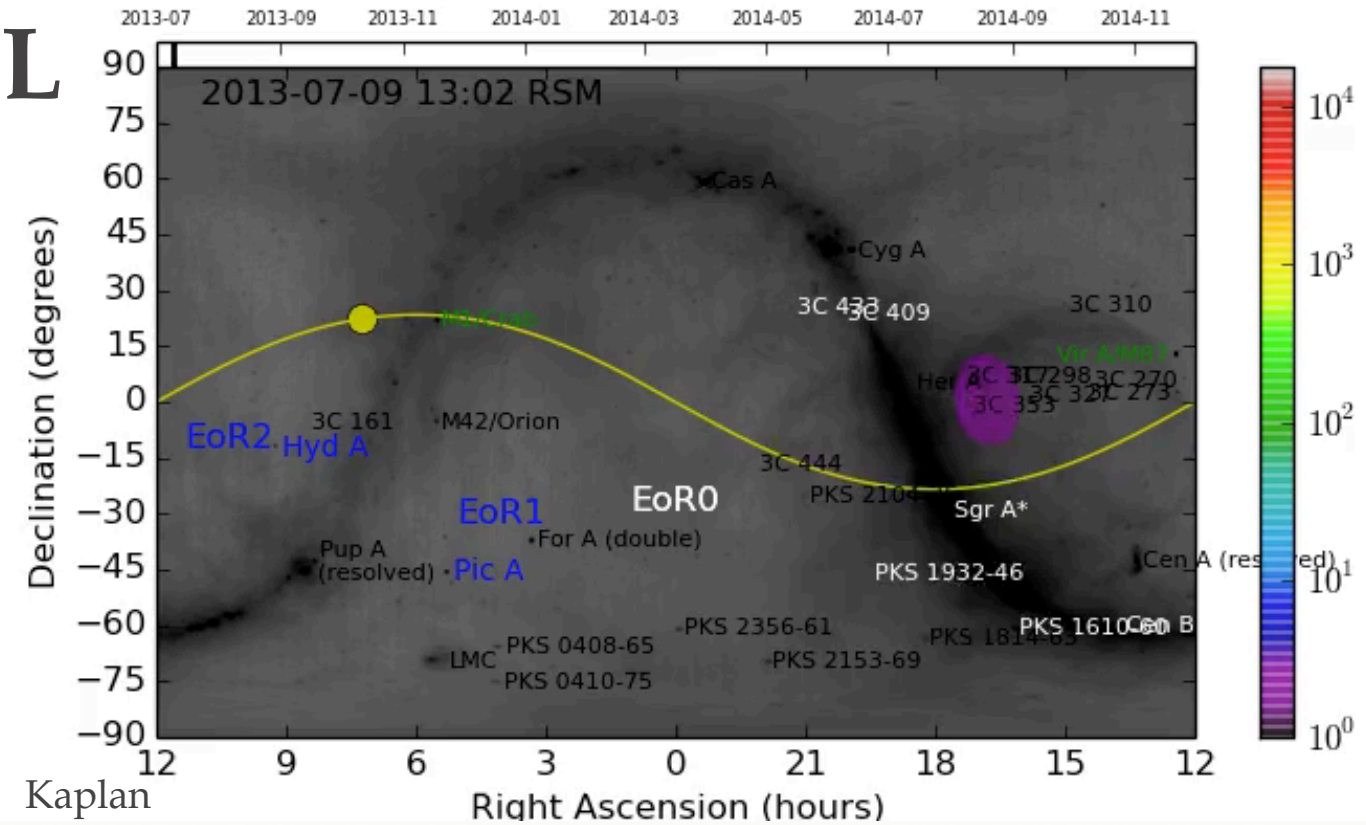
COORDINATED

GP survey
iPTF 45 nights, Jul 1 - Aug 15
MWA 18 epochs x 1 hour (14 x 4 min snapshots) every ~2 days
118, 154, 185 MHz
$|b|<20°$, $15° <l< 50°$

MWA IPTF EPOCH 1



ARCHIVAL



Kaplan

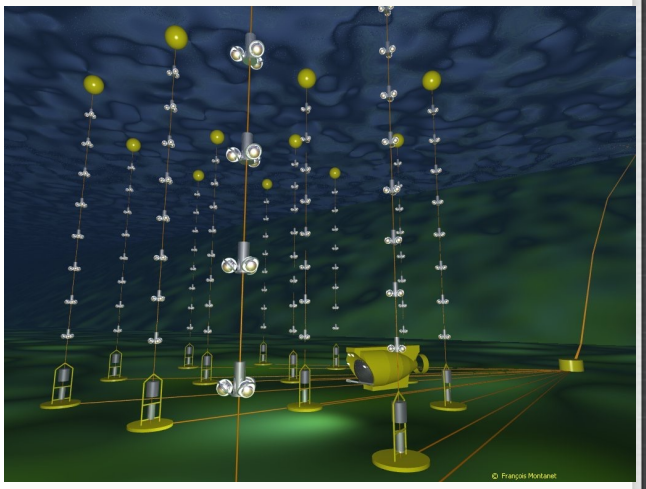
MURCHISON WIDEFIELD ARRAY LIMITS ON RADIO EMISSION FROM ANTARES NEUTRINO EVENTS

S. Croft[1,2], D. L. Kaplan[3], S. J. Tingay[4,5], T. Murphy[5,6], M. E. Bell[7], A. Rowlinson[7], for the MWA Collaboration

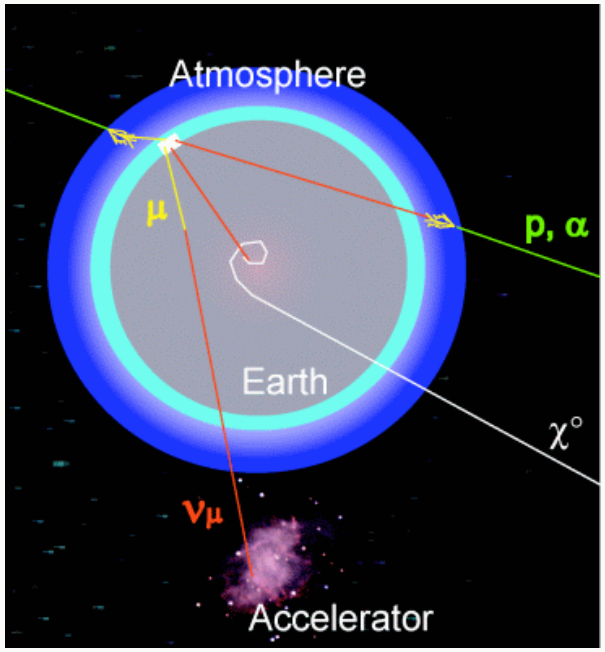
S. Adrián-Martínez[8], M. Ageron[12], A. Albert[9], M. André[10], G. Anton[11], M. Ardid[8], J.-J. Aubert[12], B. Baret[13], J. Barrios-Martí[14], S. Basa[15], V. Bertin[12], S. Biagi[16], R. Bormuth[17,18], M. C. Bouwhuis[17], R. Bruijn[17,19], J. Brunner[12], J. Busto[12], A. Capone[20,21], L. Caramete[22], J. Carr[12], T. Chiarusi[23], M. Circella[24], A. Coleiro[13], R. Coniglione[16], H. Costantini[12], P. Coyle[12], A. Creusot[13], I. Dekeyser[25], A. Deschamps[26], G. De Bonis[20,21], C. Distefano[16], C. Donzaud[13,27], D. Dornic[12], D. Drouhin[9], T. Eberl[11], I. El Bojaddaini[28], D. Elsässer[29], A. Enzenhöfer[11], K. Fehn[11], I. Felis[8], P. Fermani[20,21], L. A. Fusco[23,30], S. Galatà[13], P. Gay[31], S. Geisselsöder[11], K. Geyer[11], V. Giordano[32], A. Gleixner[11], H. Glotin[33], R. Gracia-Ruiz[13], K. Graf[11], S. Hallmann[11], H. van Haren[34], A. J. Heijboer[17], Y. Hello[26], J. J. Hernández-Rey[14], J. Hössl[11], J. Hofestädt[11], C. Hugon[35,36], C. W James[11], M. de Jong[17,18], M. Kadler[29], O. Kalekin[11], U. Katz[11], D. Kiessling[11], P. Kooijman[17,37,19], A. Kouchner[13], M. Kreter[29], I. Kreykenbohm[38], V. Kulikovskiy[16,39], C. Lachaud[13], R. Lahmann[11], D. Lefèvre[25], E. Leonora[32,40], S. Loucatos[41], M. Marcelin[15], A. Margiotta[23,30], A. Marinelli[42,43], J. A. Martínez-Mora[8], A. Mathieu[12], T. Michael[17], P. Migliozzi[44], A. Moussa[28], C. Mueller[29], E. Nezri[15], G. E. Păvălaş[22], C. Pellegrino[23,30], C. Perrina[20,21], P. Piattelli[16], V. Popa[22], T. Pradier[45], C. Racca[9], G. Riccobene[16], K. Roensch[11], M. Saldaña[8], D. F. E. Samtleben[17,18], A. Sánchez-Losa[14], M. Sanguineti[35,36], P. Sapienza[16], J. Schmid[11], J. Schnabel[11], F. Schüssler[41], T. Seitz[11], C. Sieger[11], M. Spurio[23,30], J. J. M. Steijger[17], T. Stolarczyk[41], M. Taiuti[35,36], C. Tamburini[25], A. Trovato[16], M. Tselengidou[11], D. Turpin[12], C. Tönnis[14], B. Vallage[41], C. Vallée[12], V. Van Elewyck[13], E. Visser[17], D. Vivolo[44,46], S. Wagner[11], J. Wilms[38], J. D. Zornoza[14], J. Zúñiga[14], for the ANTARES Collaboration

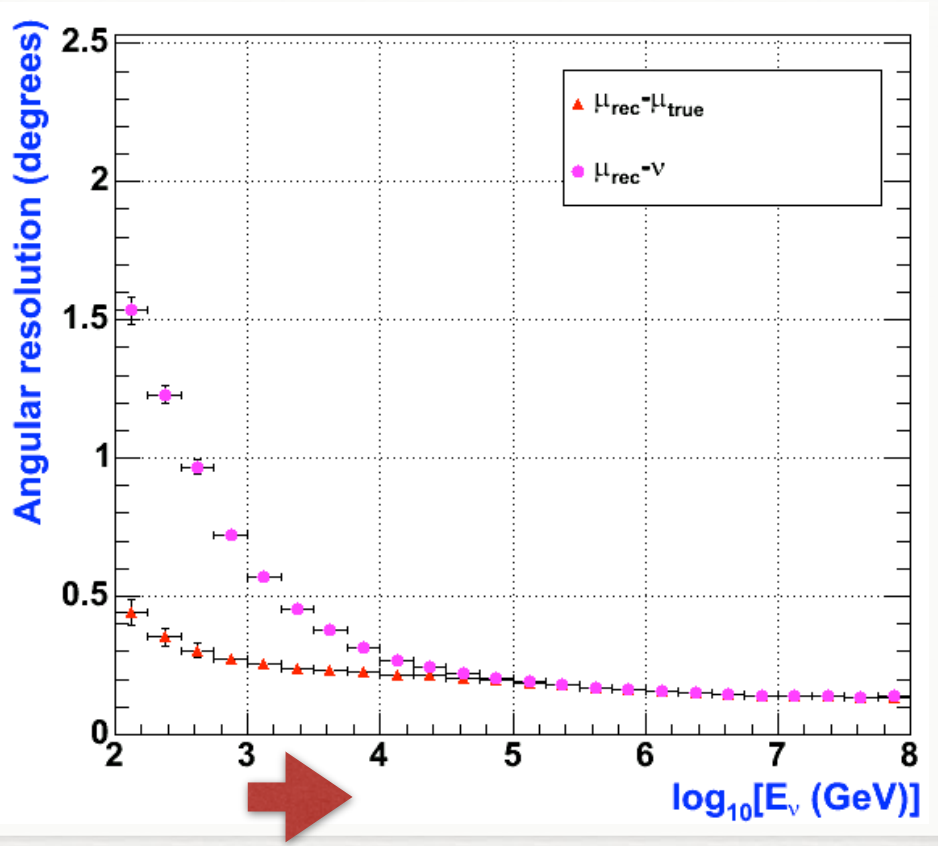
A. Klotz[47,48], M. Boer[49], A. Le Van Suu[50], for the TAROT Collaboration

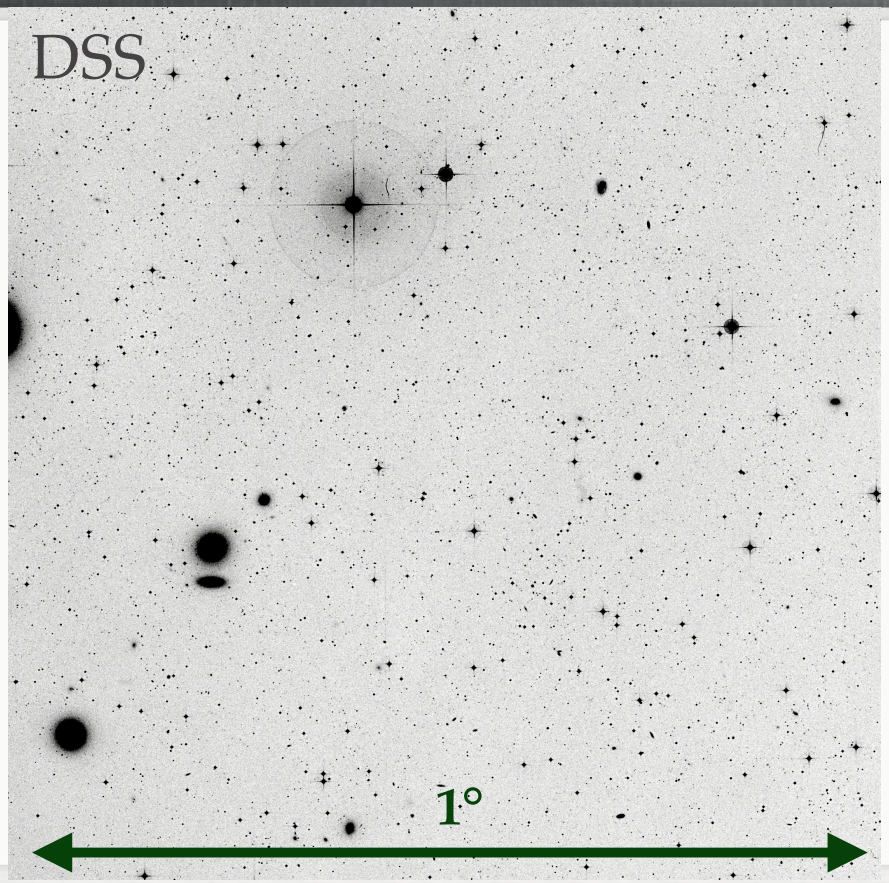
C. Akerlof[51], W. Zheng[1], for the ROTSE Collaboration

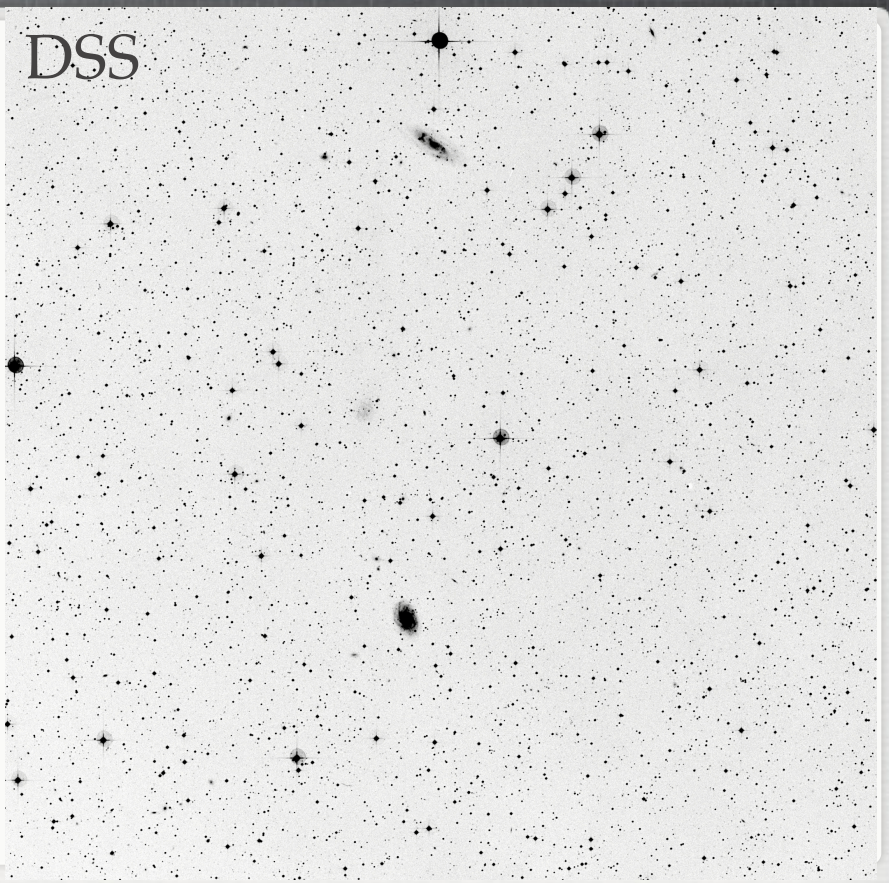


ANTARES


Atmosphere
μ
p, α
Earth
χ°
νμ
Accelerator


Angular resolution (degrees)
2.5
2
1.5
1
0.5
0
2
3
4
5
6
7
8
μrec-μtrue
μrec-ν
log10[Eν (GeV)]

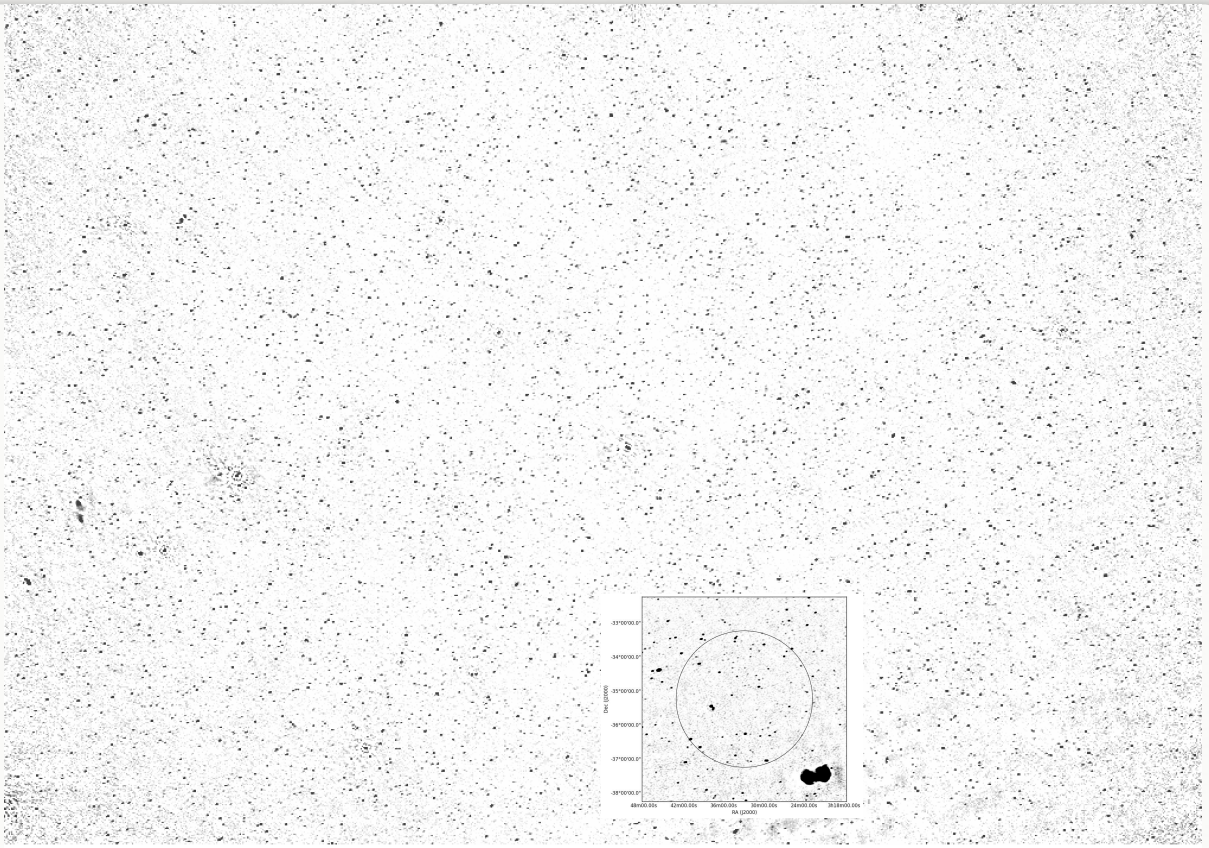




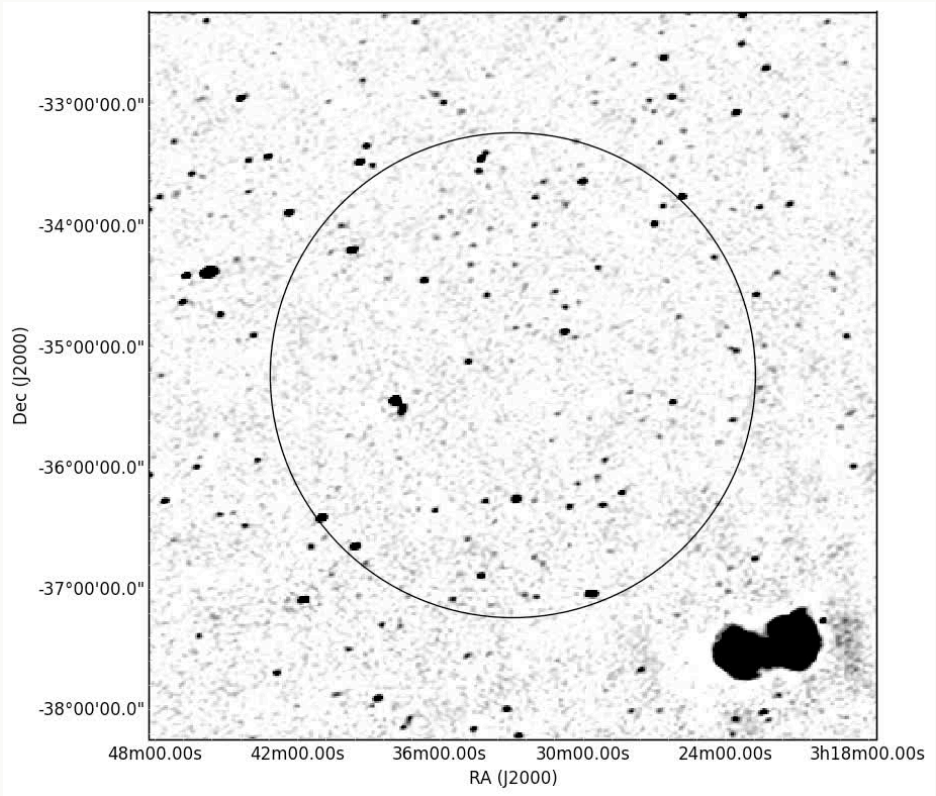
ANTARES directional trigger reduces atmospheric contamination to 2%

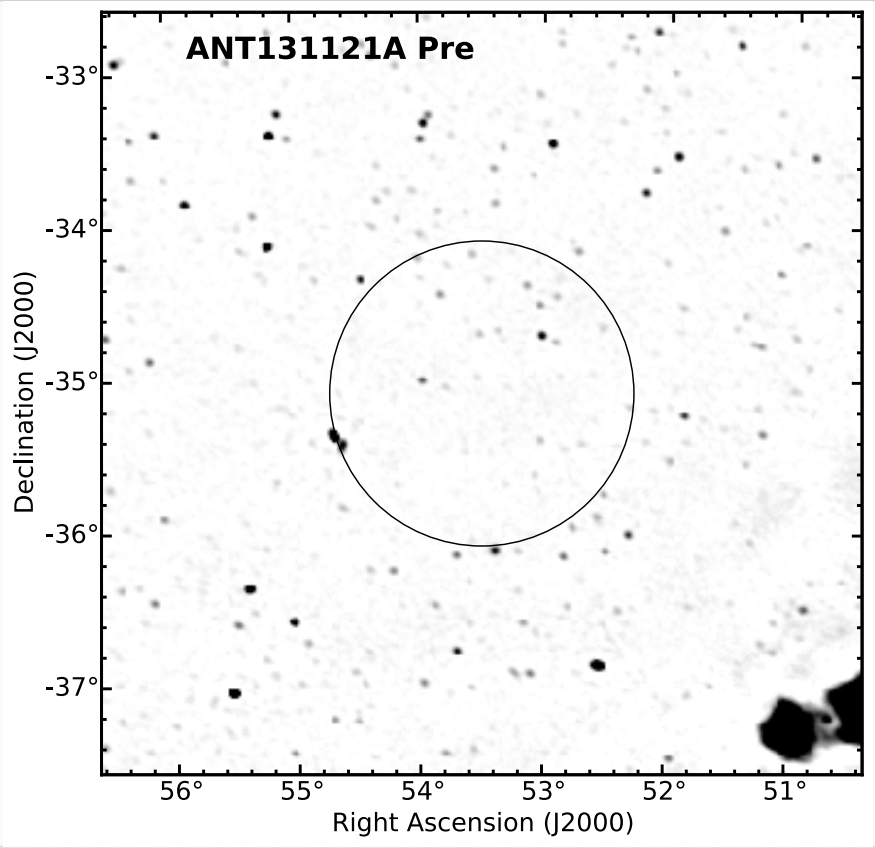
ANTARES FOLLOWUP

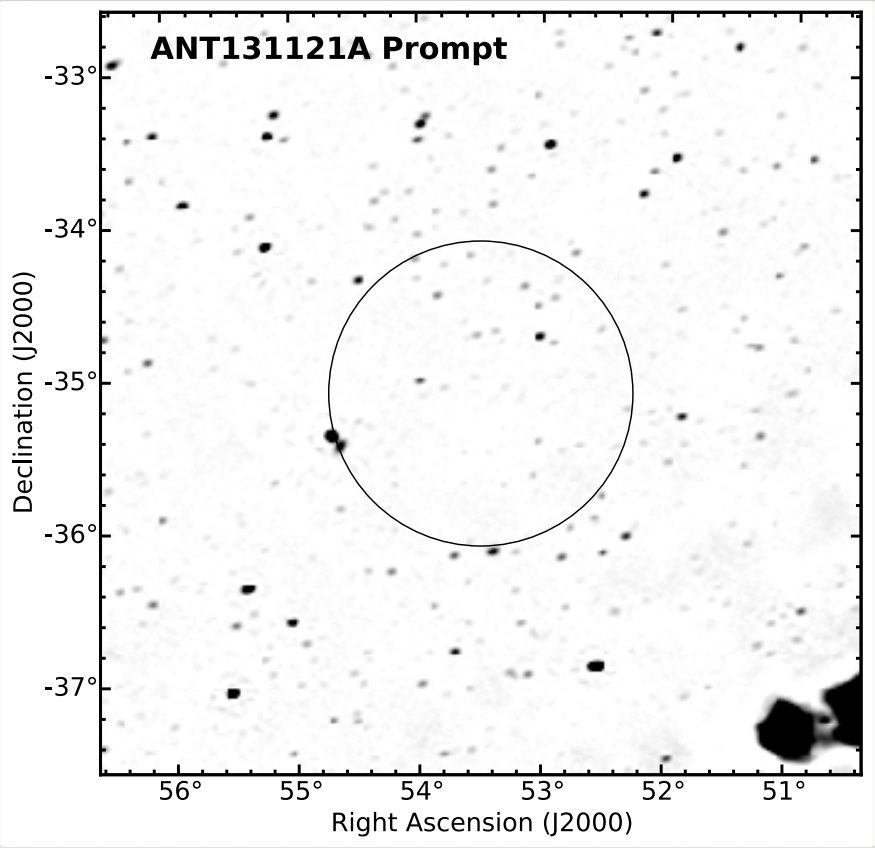
ANTARES FOLLOWUP

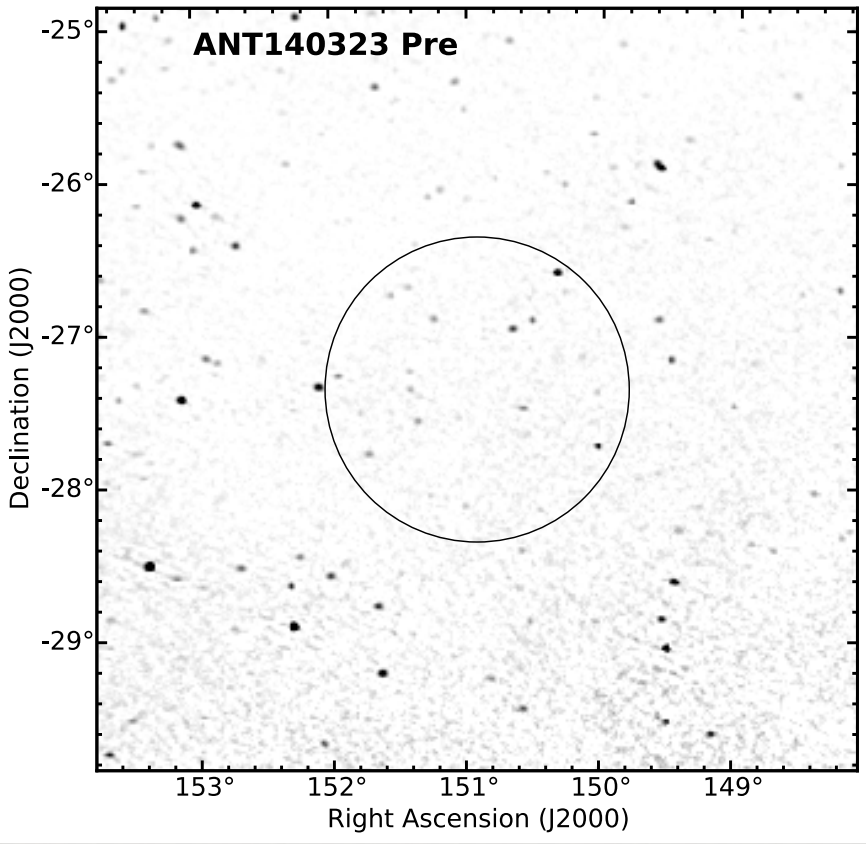


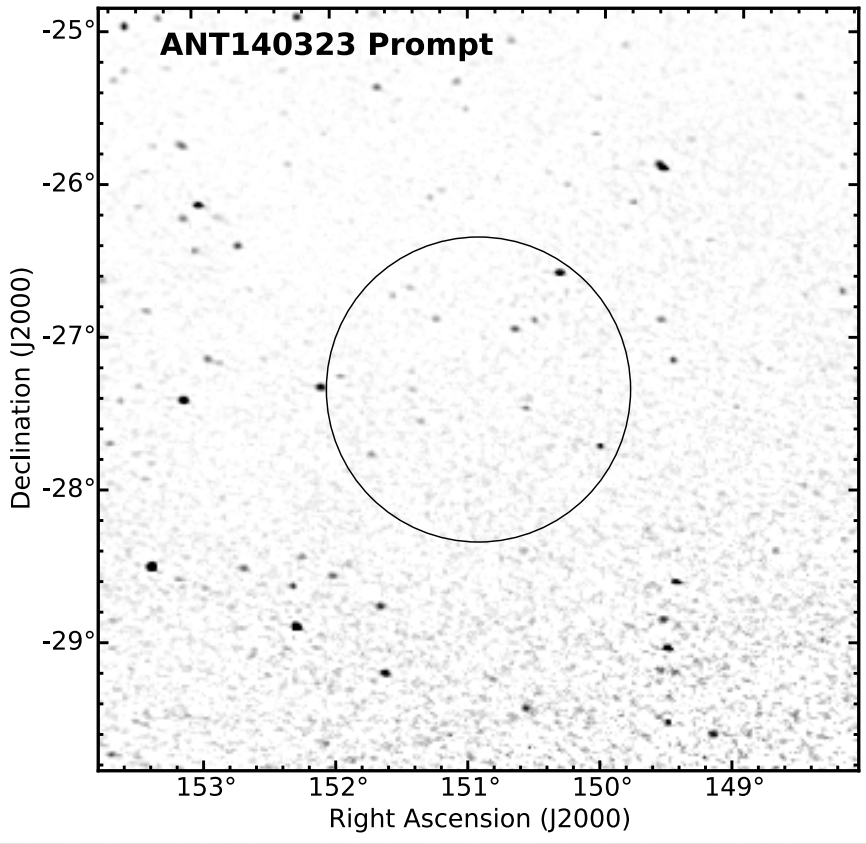
ANTARES FOLLOWUP




ANT131121A Pre
-33°
-34°
-35°
-36°
-37°
Declination (J2000)
56°
55°
54°
53°
52°
51°
Right Ascension (J2000)


ANT131121A Prompt
-33°
-34°
-35°
-36°
-37°
Declination (J2000)
56°
55°
54°
53°
52°
51°
Right Ascension (J2000)


ANT140323 Pre
-25°
-26°
-27°
-28°
-29°
Declination (J2000)
153°
152°
151°
150°
149°
Right Ascension (J2000)


ANT140323 Prompt
-25°
-26°
-27°
-28°
-29°
Declination (J2000)
153°
152°
151°
150°
149°
Right Ascension (J2000)

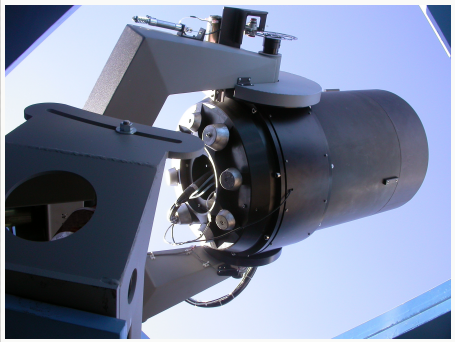
ANTARES FOLLOWUP

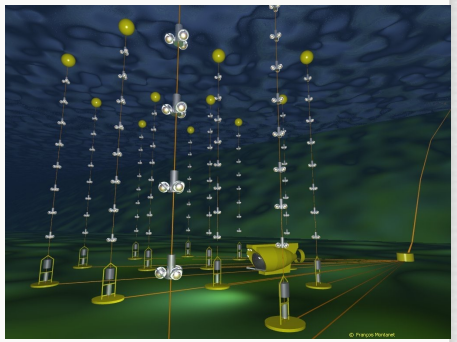
No counterparts to ~19 mag

No counterparts to ~100 mJy

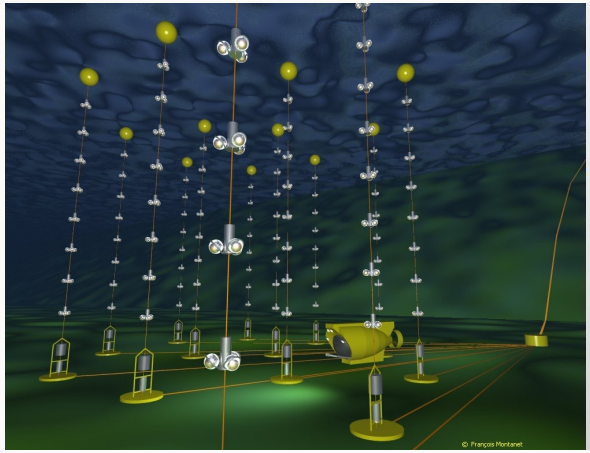
$L_{150\,\mathrm{MHz}} \lesssim 10^{29}\ \mathrm{erg\ s^{-1}\ Hz^{-1}}$ if at < 20 Mpc

If binary neutron star coalescences, progenitors must be at z > 0.2

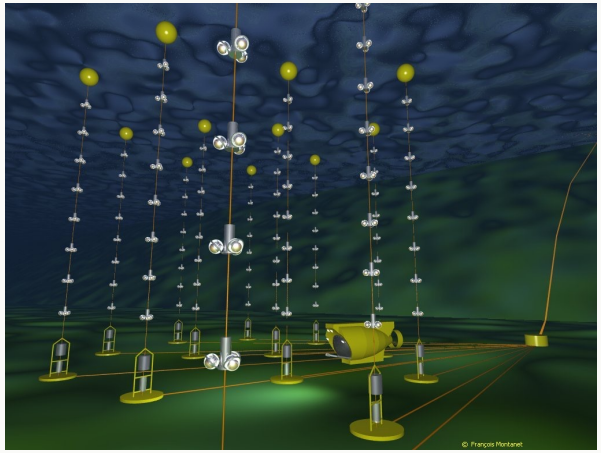


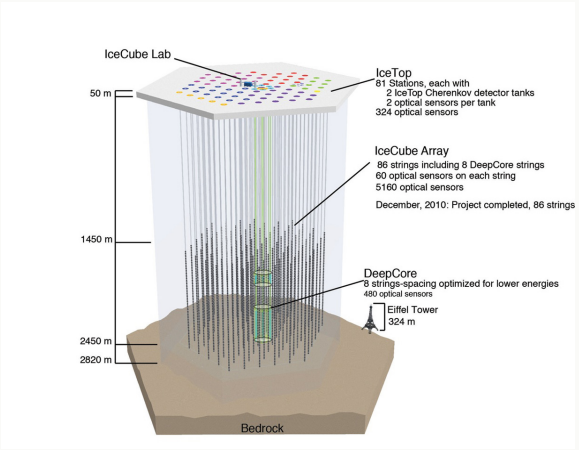



MULTI-MESSENGER TRIGGERED FOLLOWUP

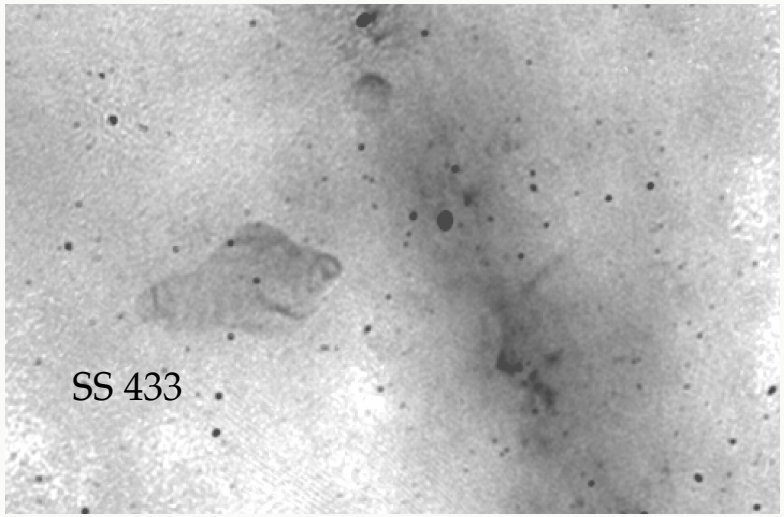


MULTI-MESSENGER TRIGGERED FOLLOWUP





NEXT STEPS

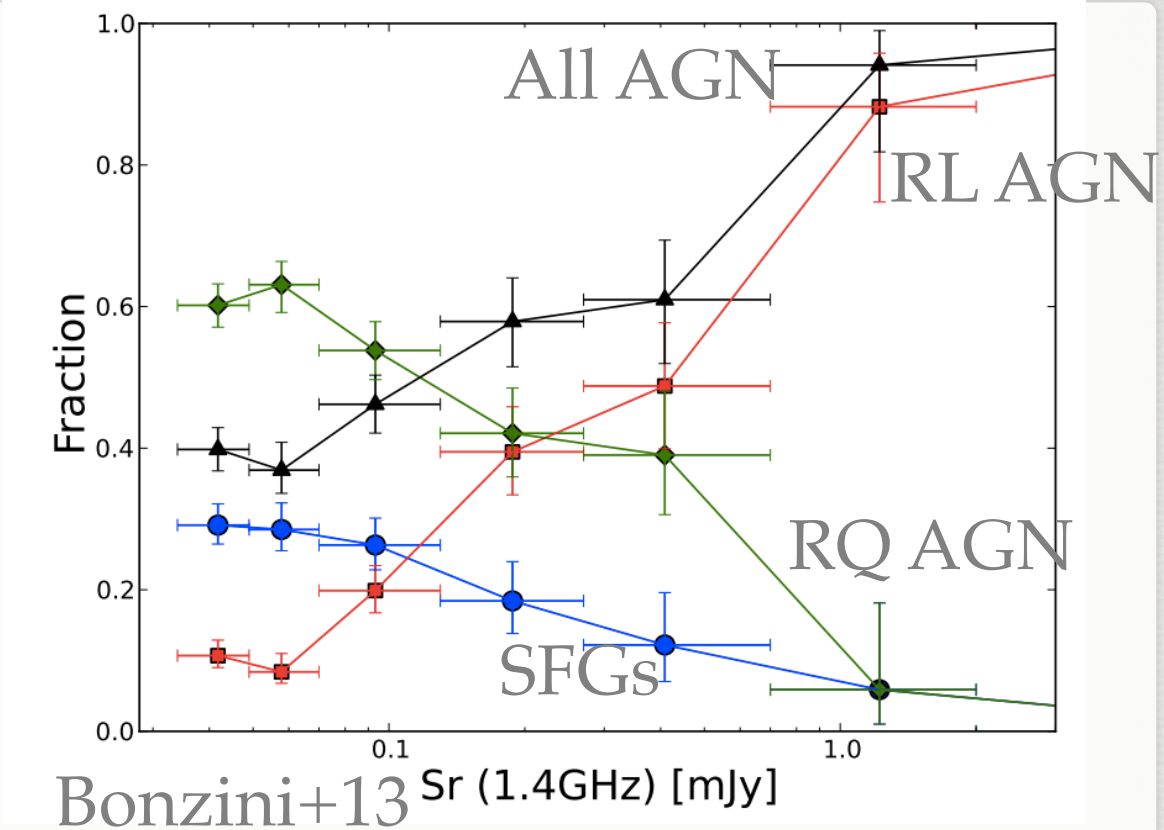


Shadowing Parkes for FRBs (expect 0.5 Jy in 0.5 s image for bright FRBs)
Triggered neutrinos, GW
X-ray binaries, AGN

MWA Phase II
Double longest baseline
2x better localization
5x lower confusion

AGN DOMINATE

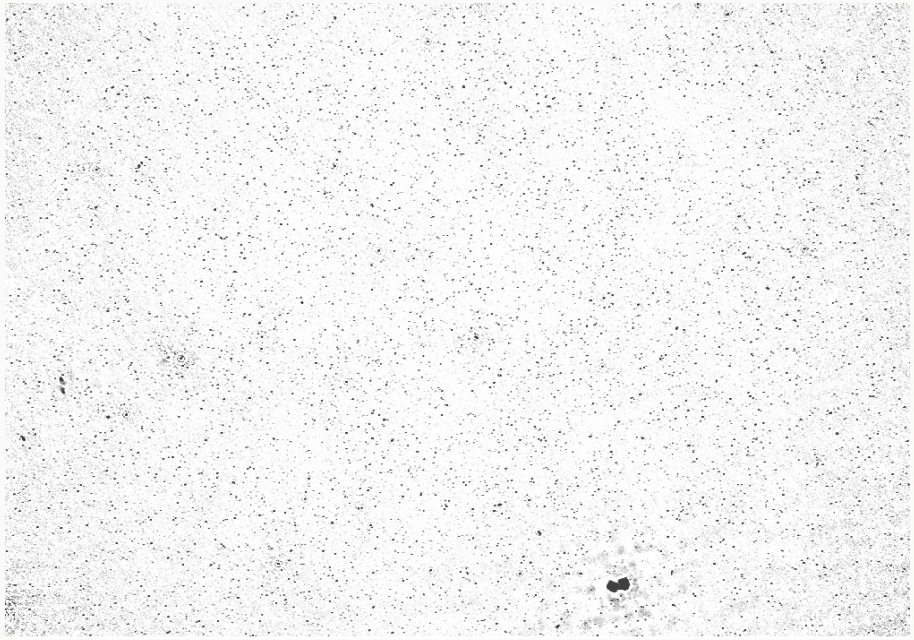
(even for SKA)



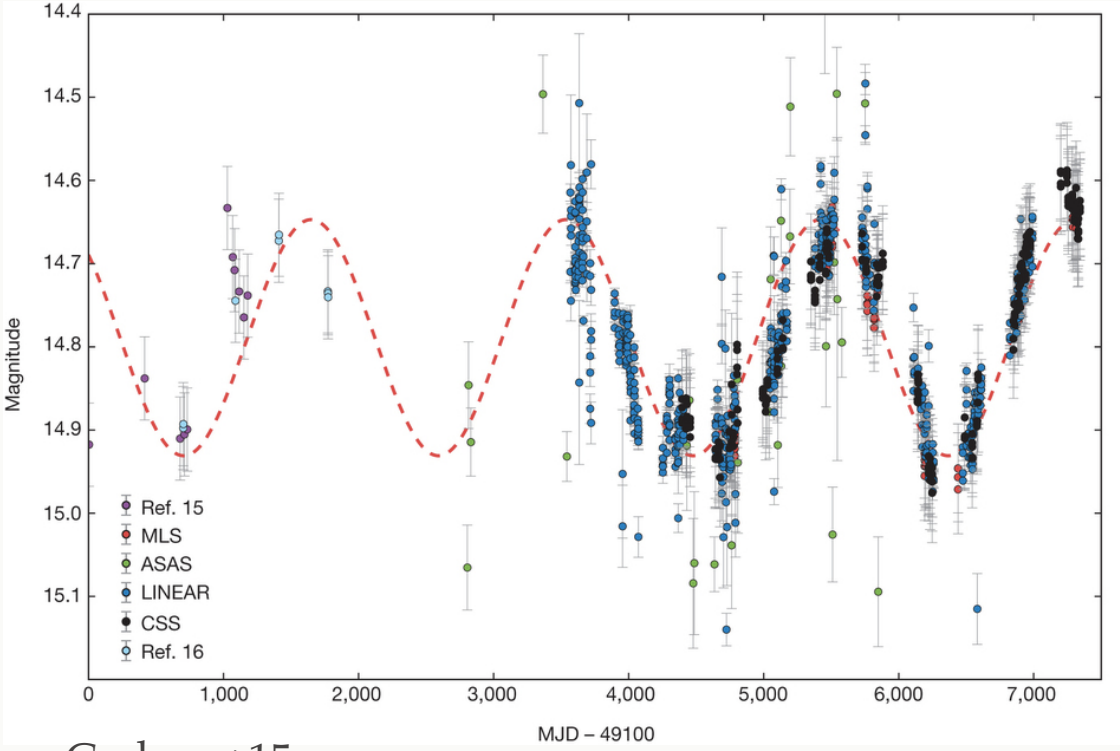
Bonzini+13

MWA

- FOV 1000 sq. deg
- RMS ~ 20 mJy / beam
- Thousands of AGN in each image
- Hundreds detected at > 10 sigma
- Typical cadence ~1 month



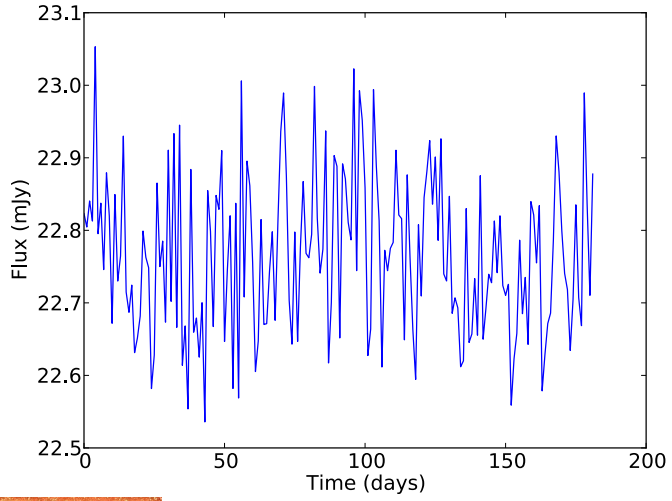
TIME DOMAIN

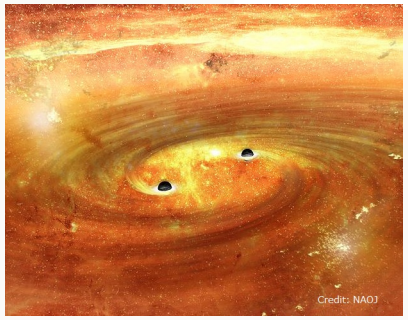


Graham+15

INSPIRAL SIGNATURES

- Unlikely to catch brief flares hours before merger
- Could maybe see modulation of emission at earlier times





O'Shaughnessy+11
Kaplan+11
Croft, O'Shaughnessy & Kaplan in prep.