



Uncovering the Sub-100 MHz Radio Transient Population with the OVRO-LWA

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on behalf of the OVRO-LWA collaboration

The 137-hr OVRO-LWA Transient Survey

Number of antennas: 256

Bandwidth: 28-85 MHz

Integration time: 13 seconds

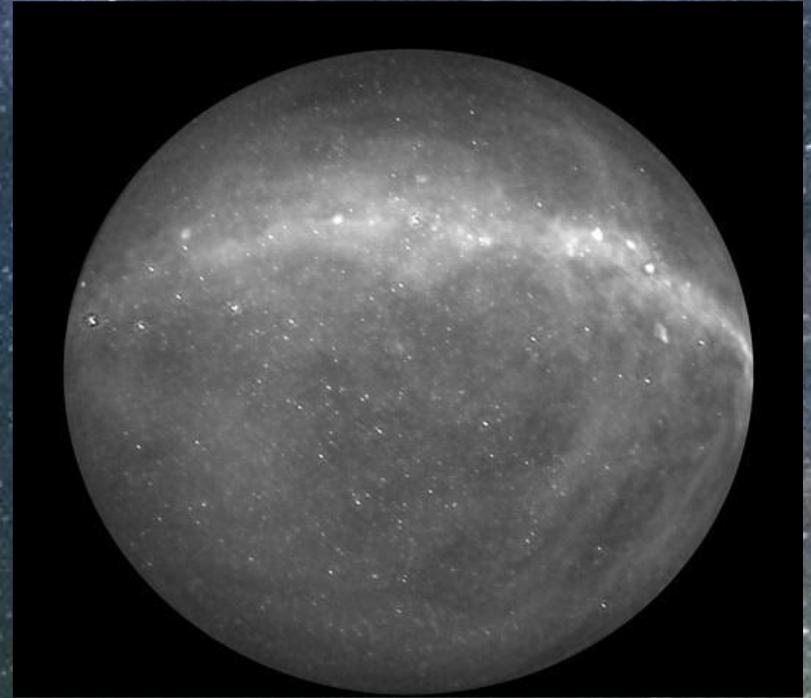
Snapshot FOV: 17,000 deg²

Resolution: ~8 arcmin

Data volume: 95TB

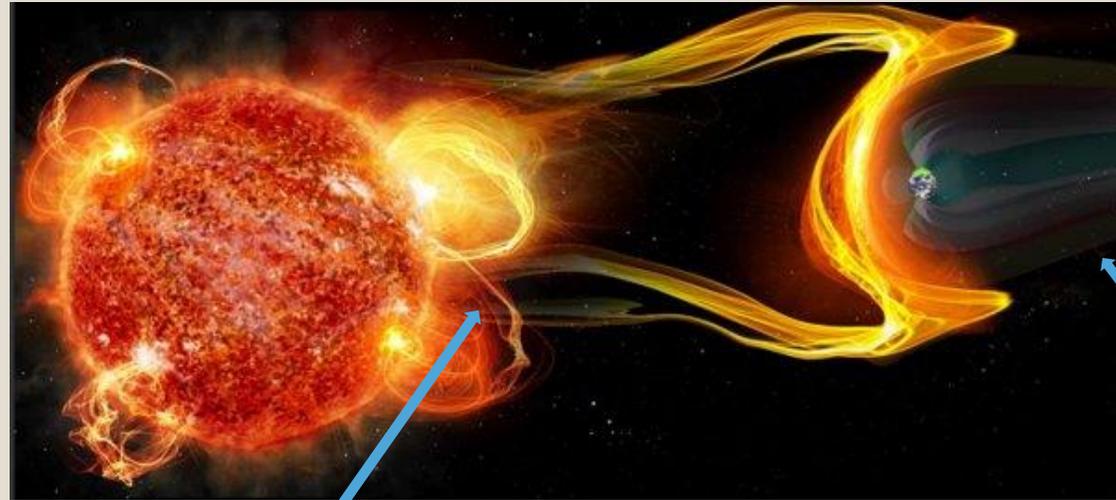
Timescales probed: 13s – 1 day

Flux scales probed: few Jy



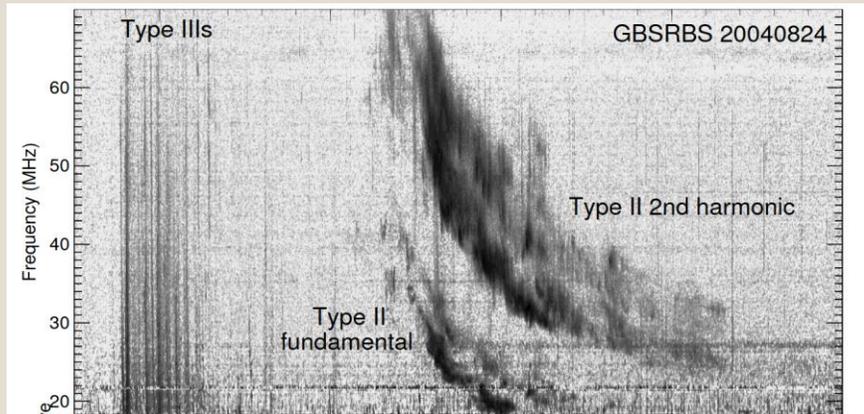
Potential transient sources at <100MHz

Extrasolar space weather events: Solar system as a prototype



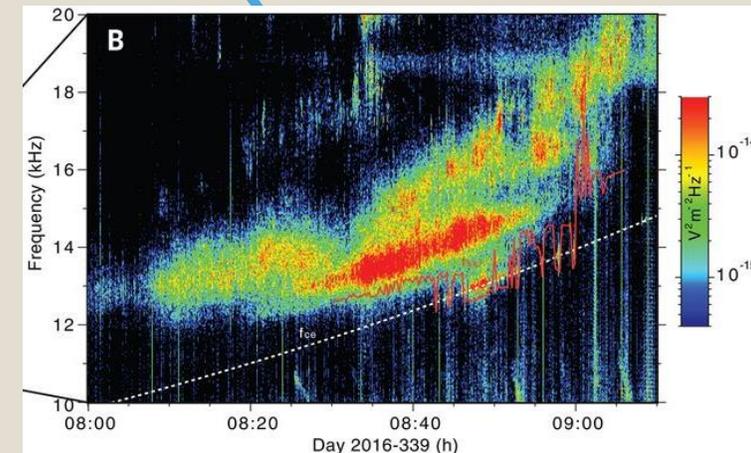
Stellar radio bursts

Electron cyclotron maser emission



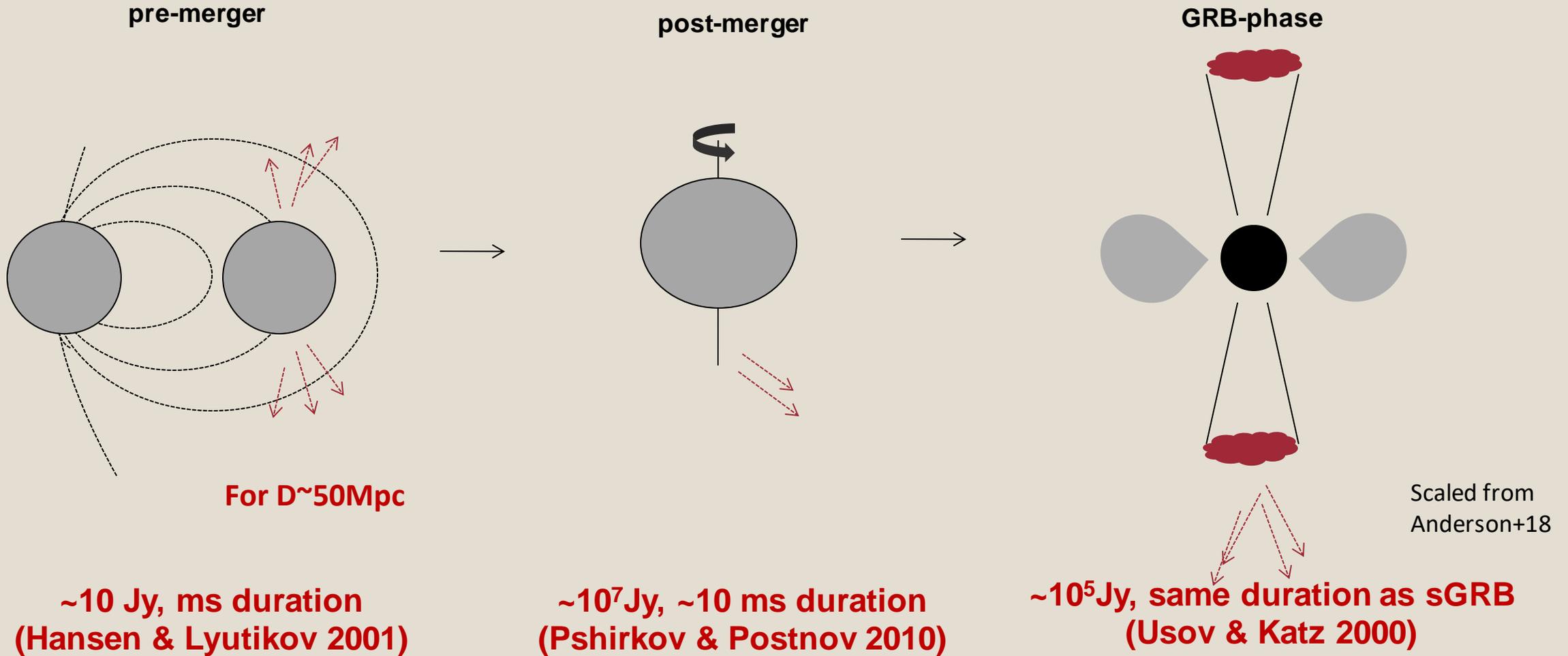
White (2007)

See also [Davis+20](#) for a marginal flare detection from EQ Peg at 60-80 MHz

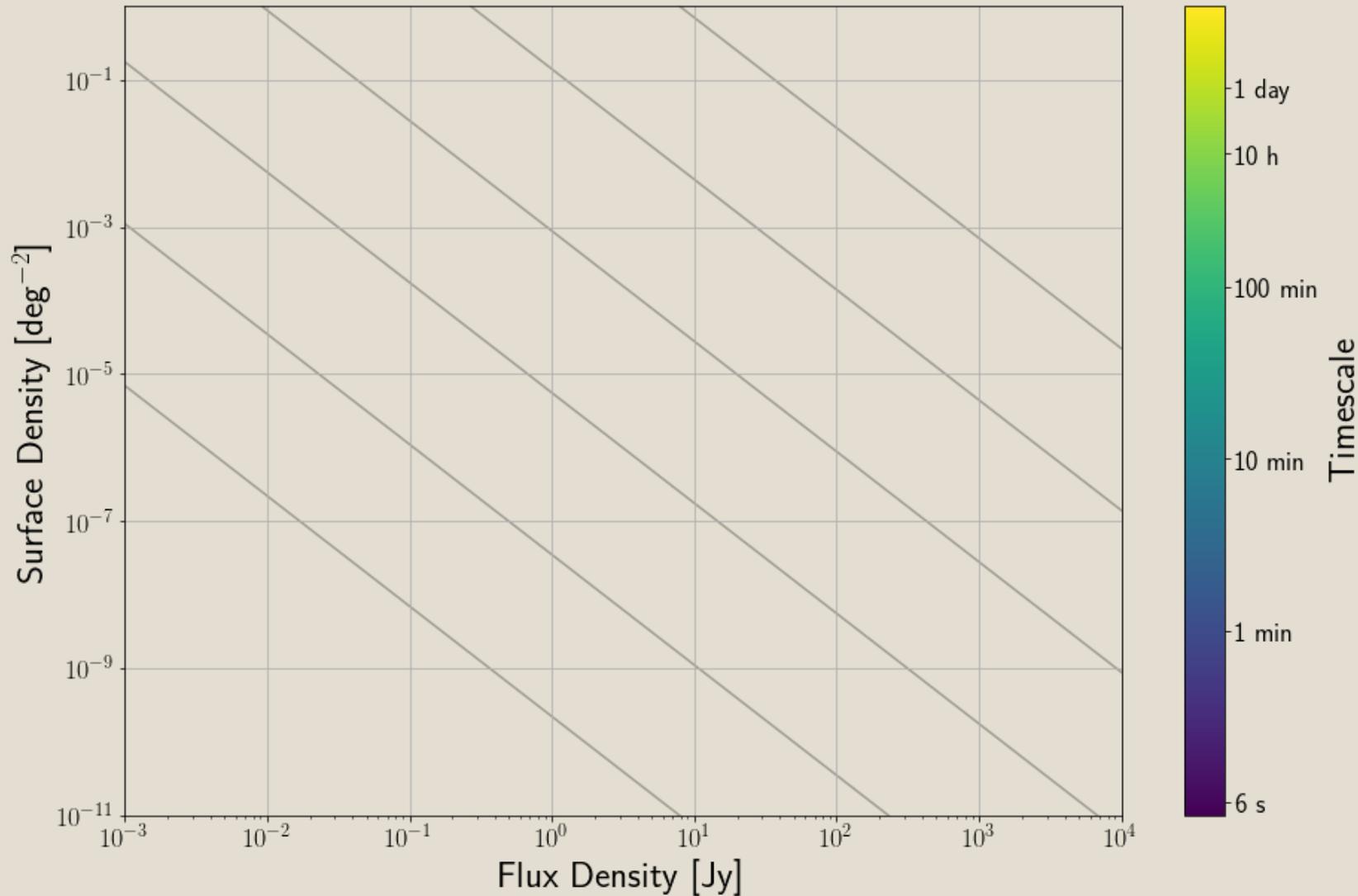


Lamy et al. (2018)

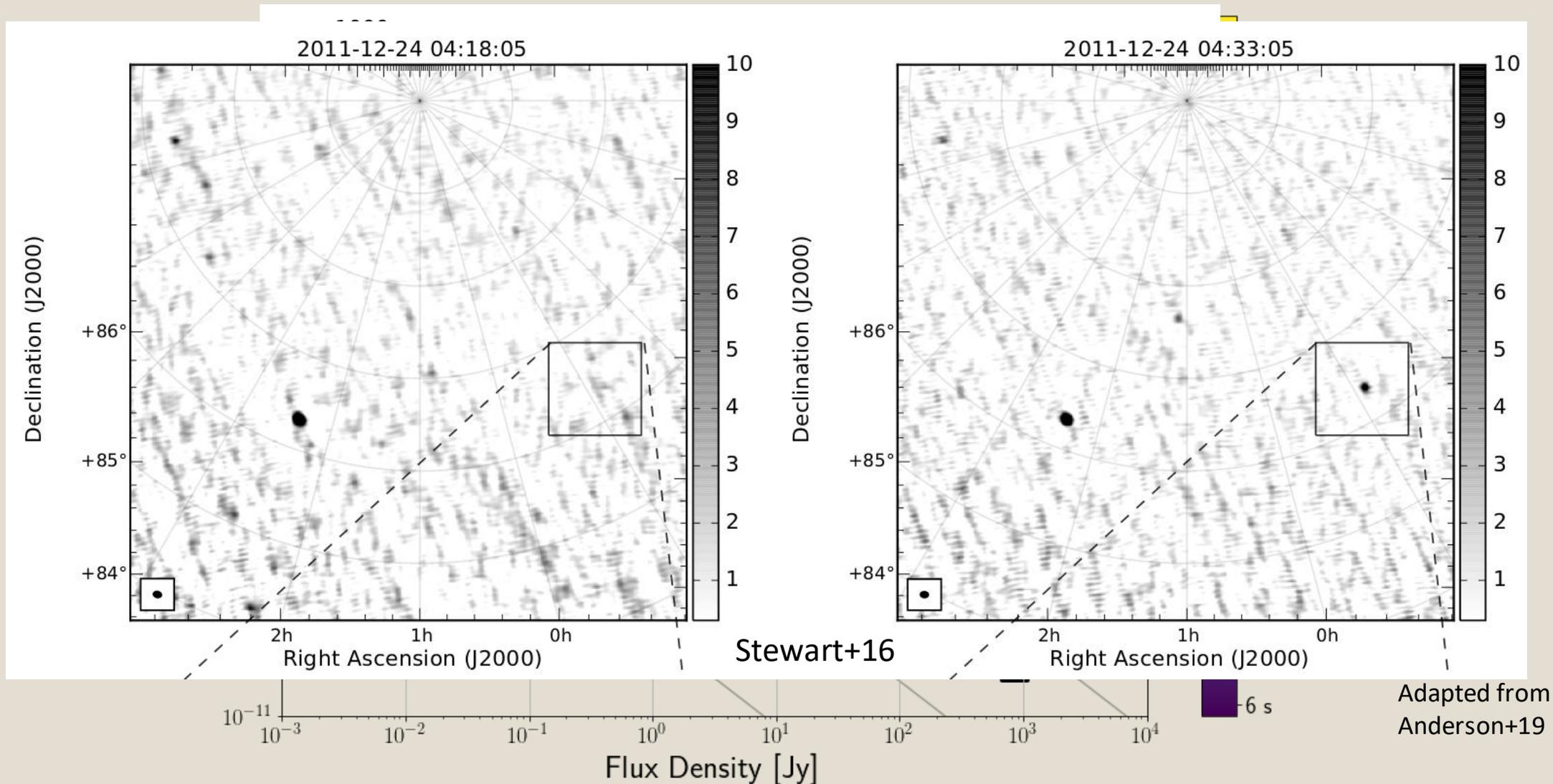
Theorized prompt Emission from BNS Mergers



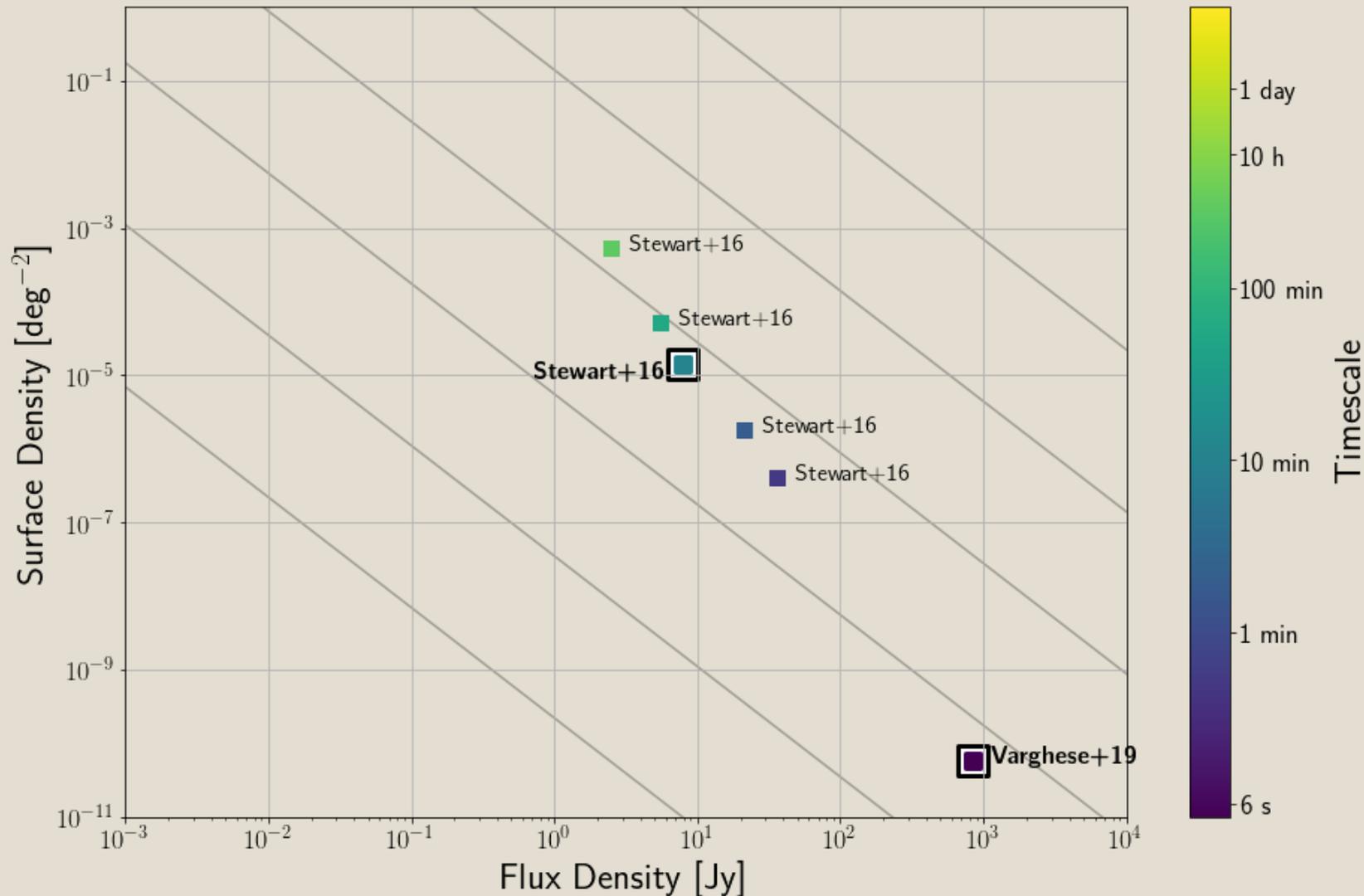
Sub-100MHz Transient Surveys



Sub-100MHz Transient Surveys

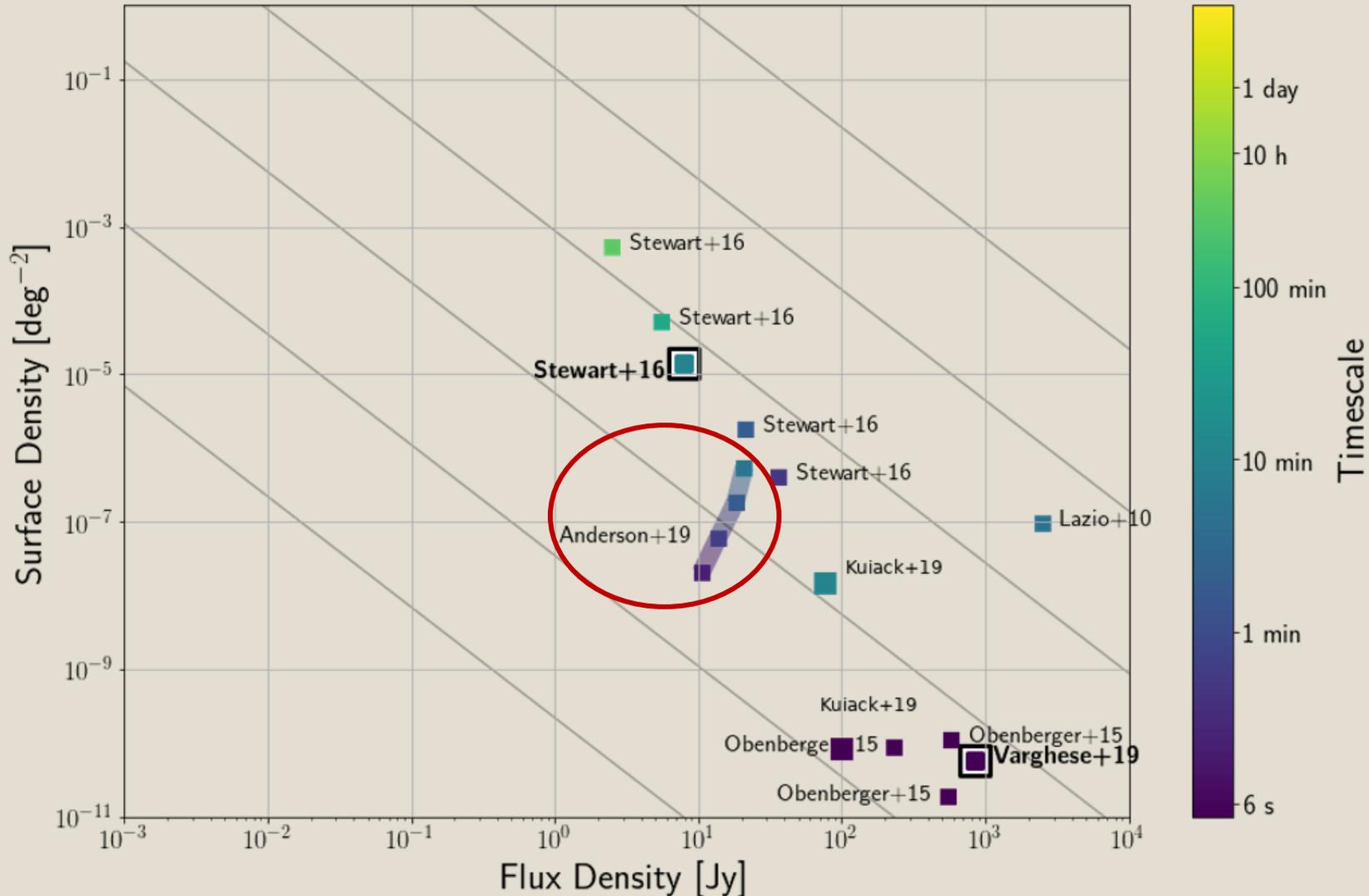


Sub-100MHz Transient Surveys



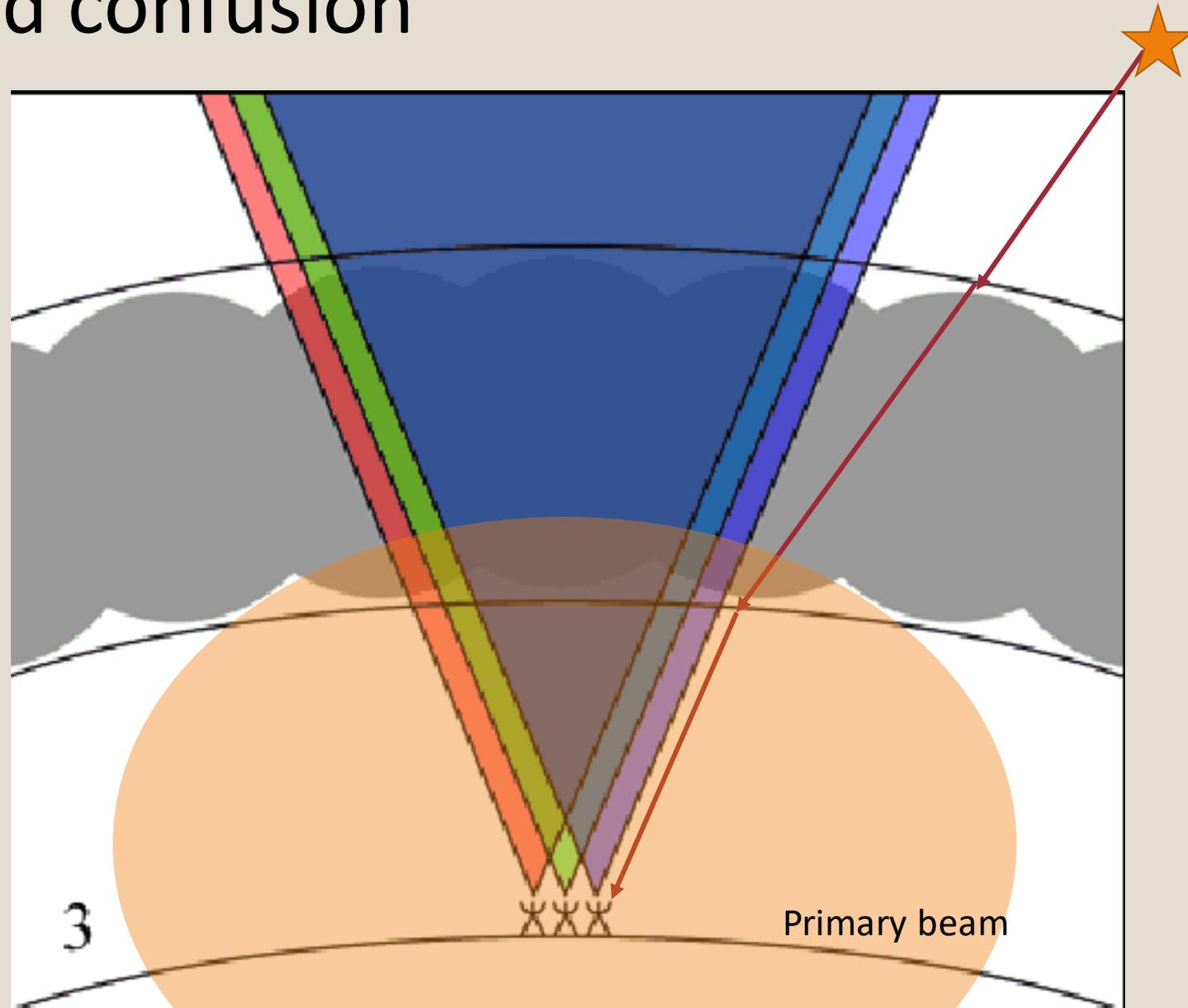
Adapted from
Anderson+19

Sub-100MHz Transient Surveys

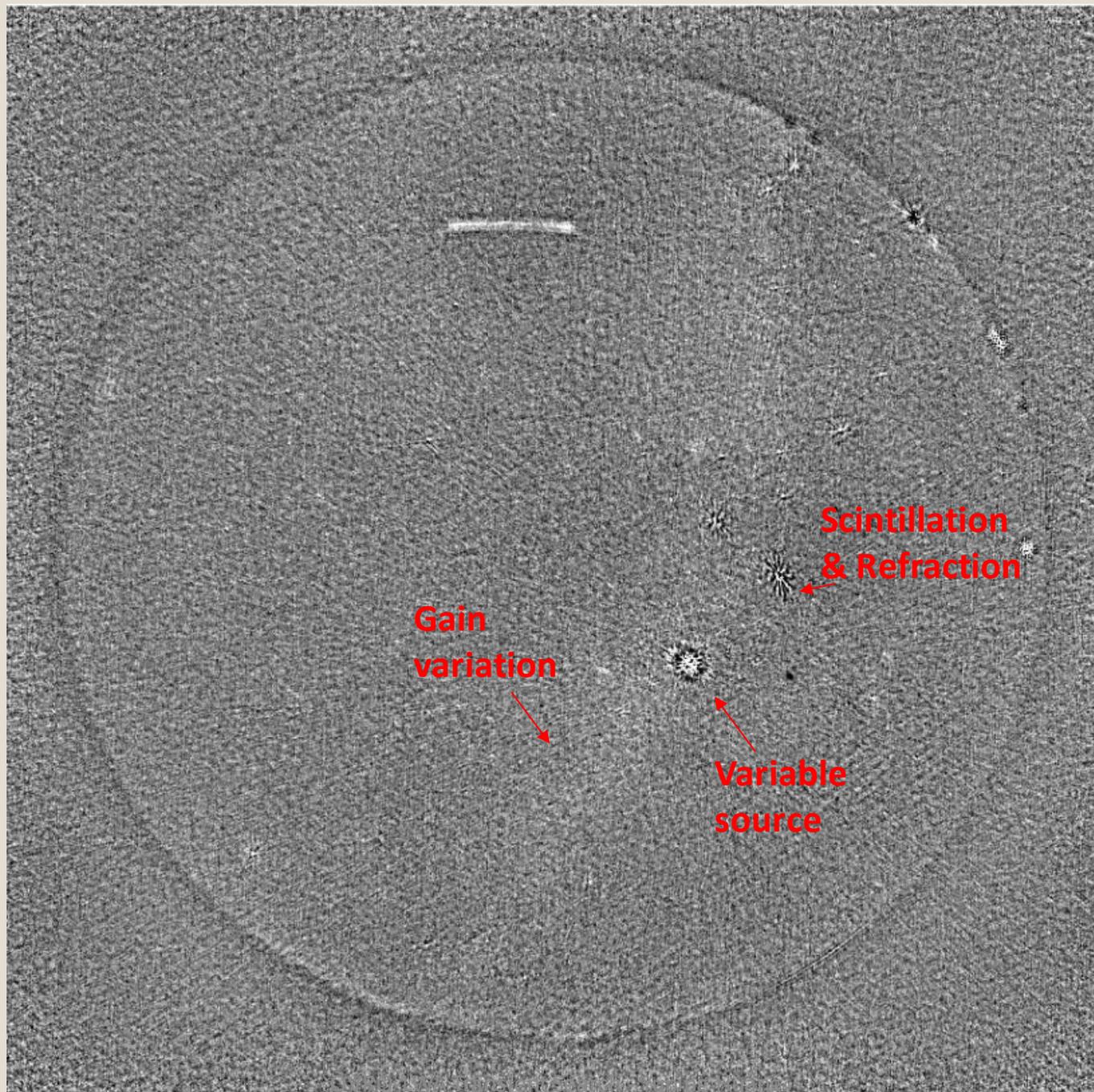


Adapted from
Anderson+19

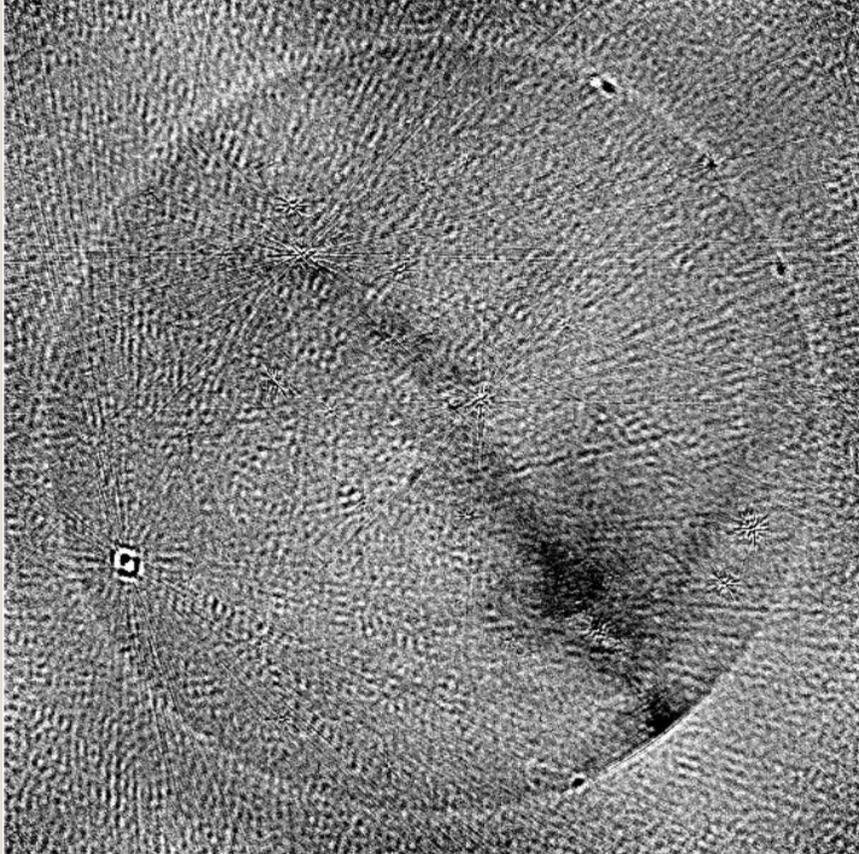
Sidereal subtraction removes primary beam effects and confusion



Adapted from
Intema+14



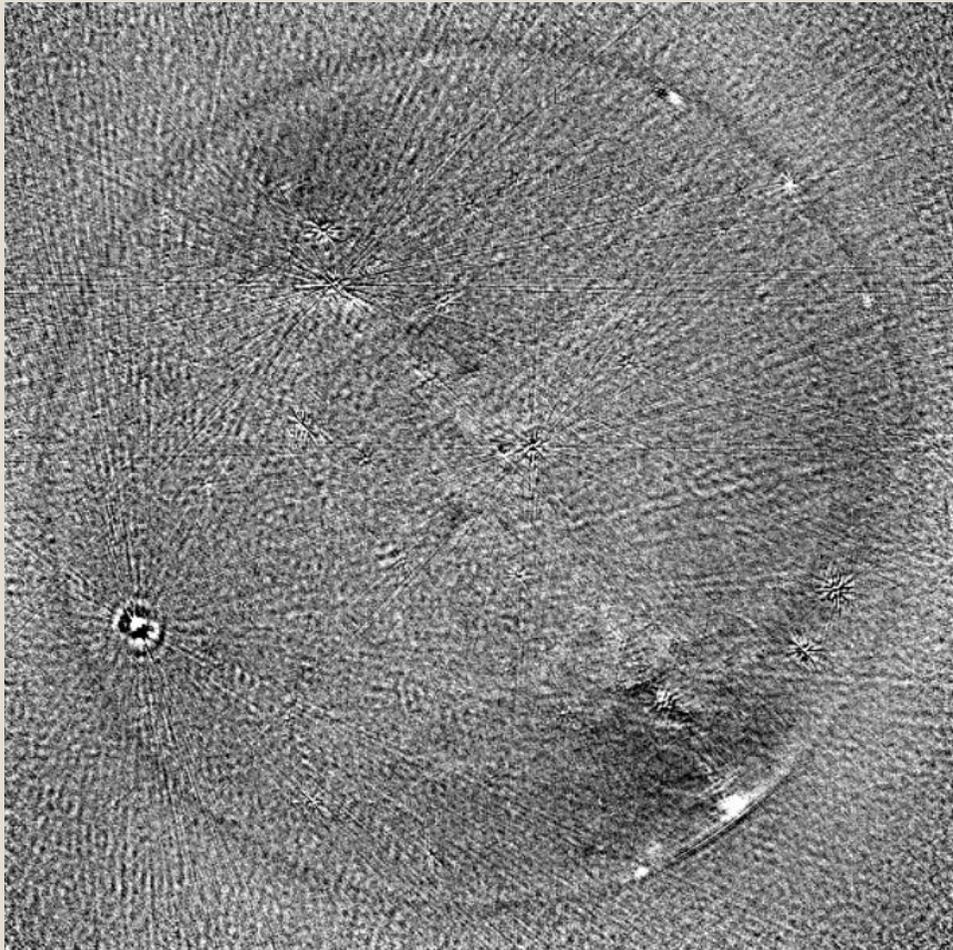
Gain correction between two snapshots



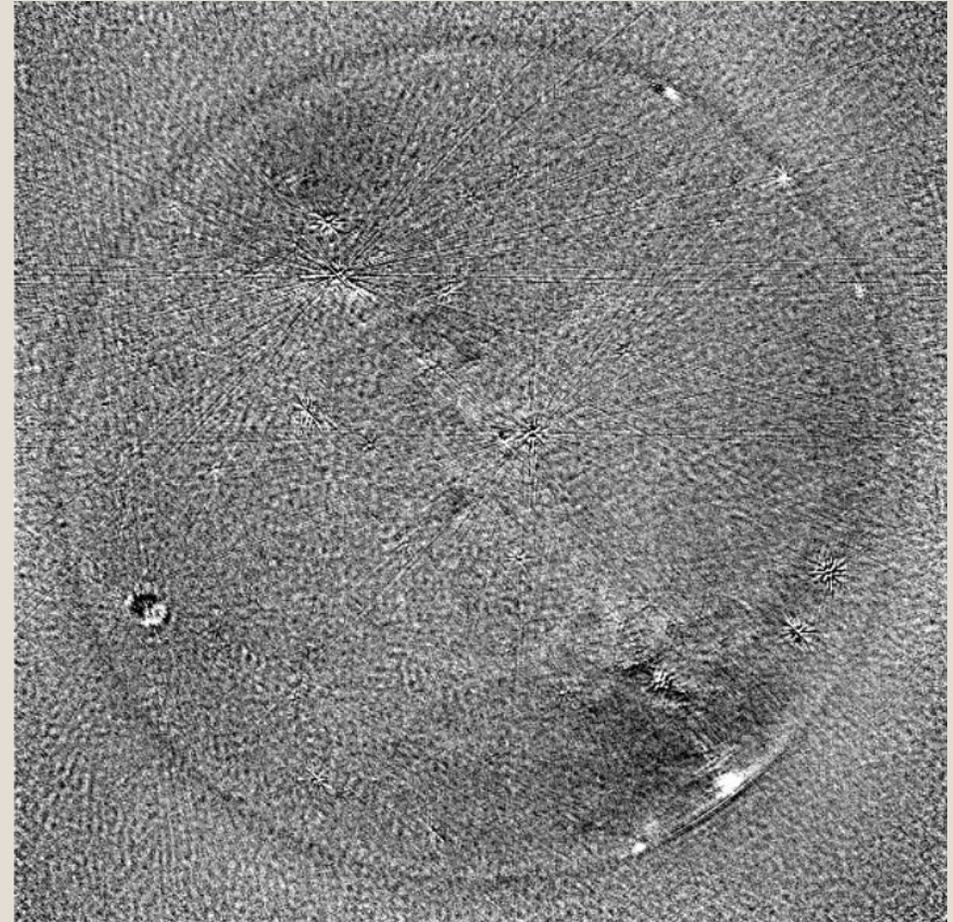
Apply per-channel per-
antenna scaling factor from
dividing autocorrelations



Using **Cotton-Schwab CLEAN** on the Sun and the Crab pulsar reduces their sidelobes

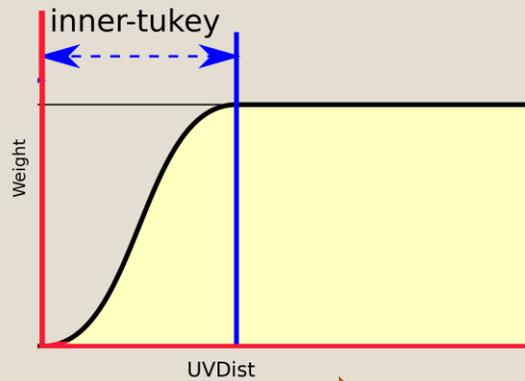
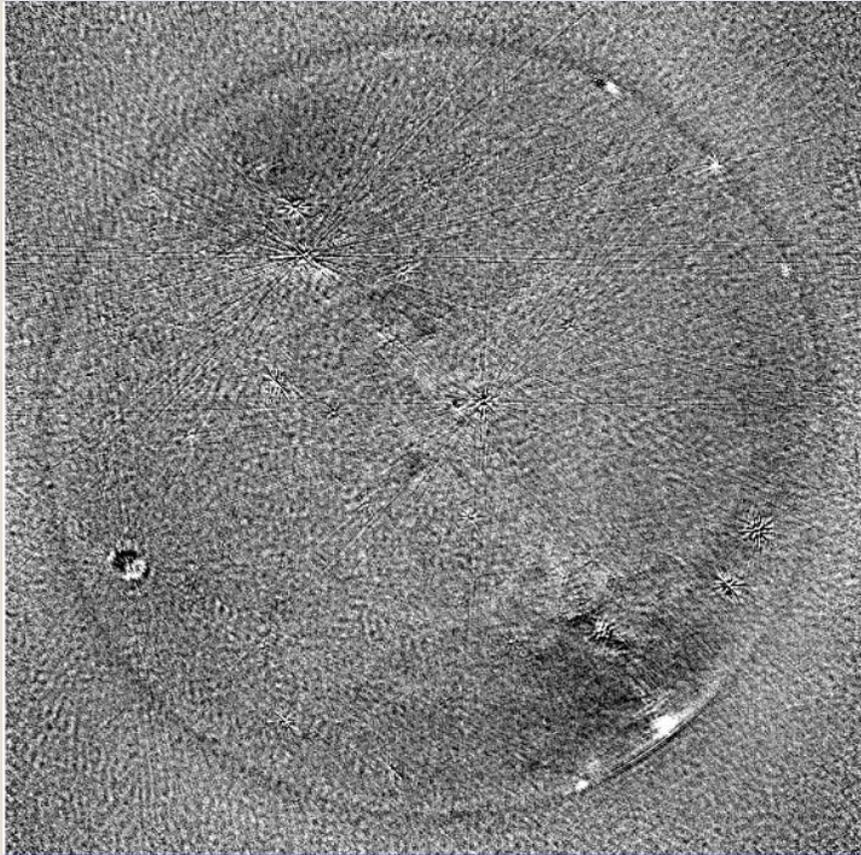


Before

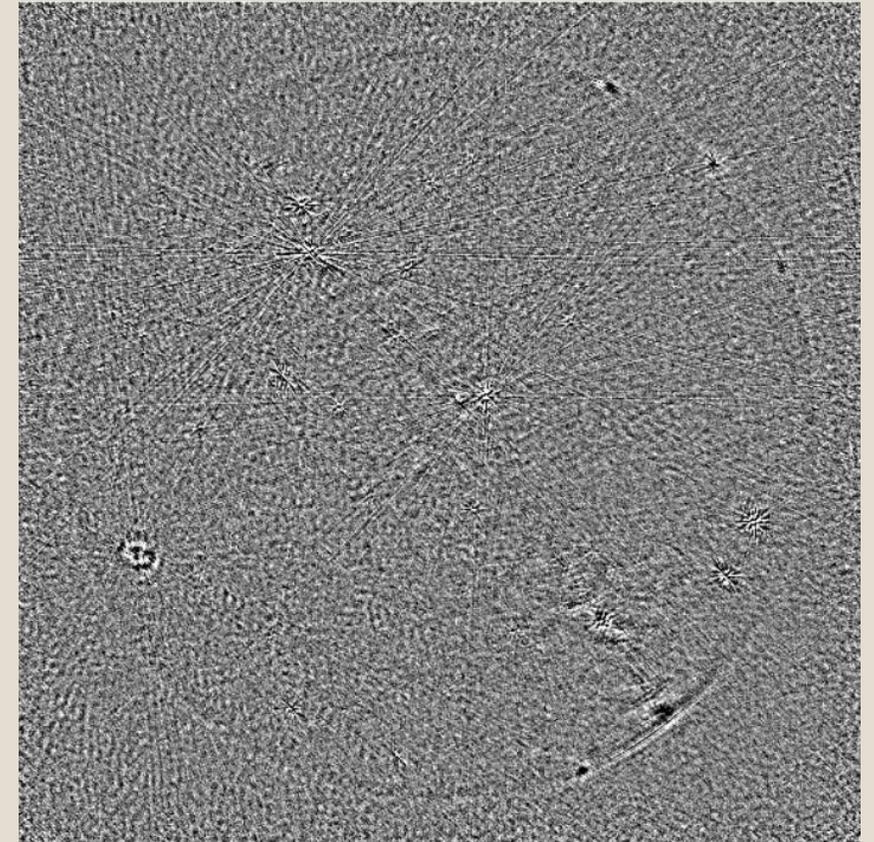


After

Inner Tukey taper suppresses short-baseline flux variation

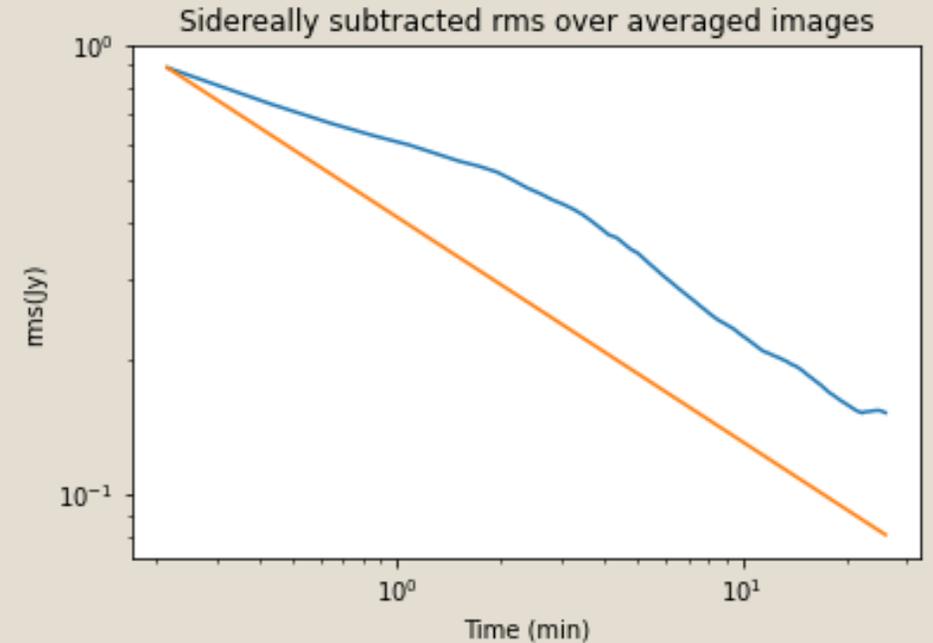
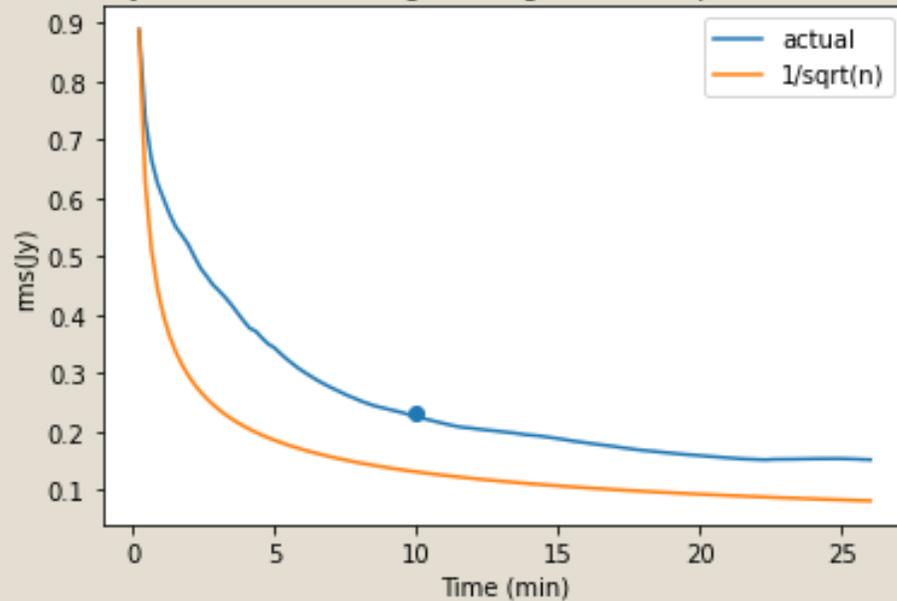


Inner Tukey 20 lambda

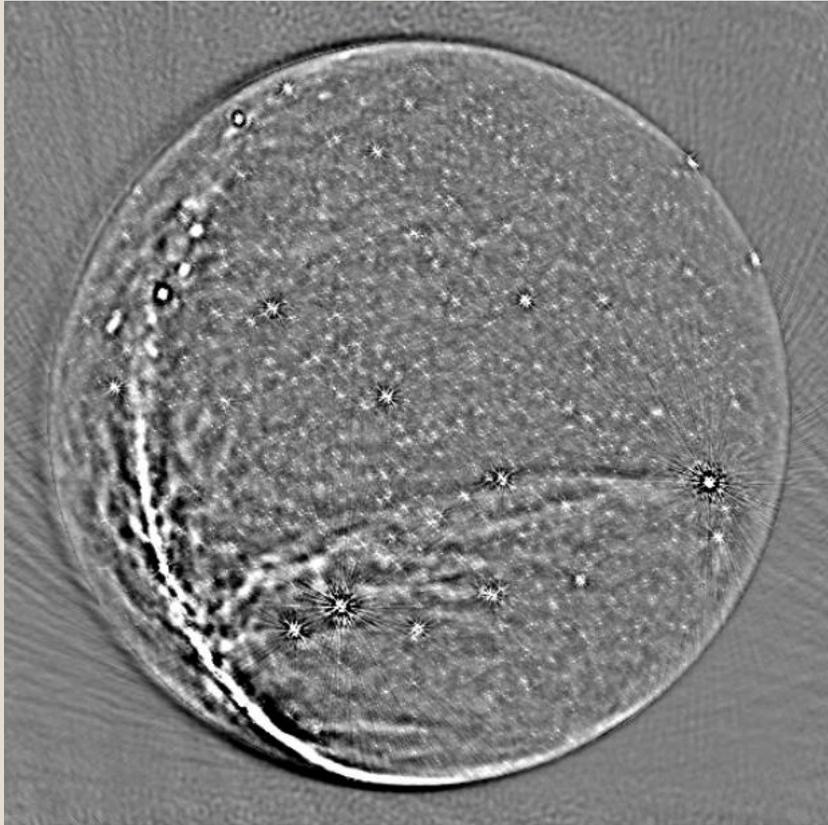


Sidereally subtracting longer integrations leads to **better sensitivity**

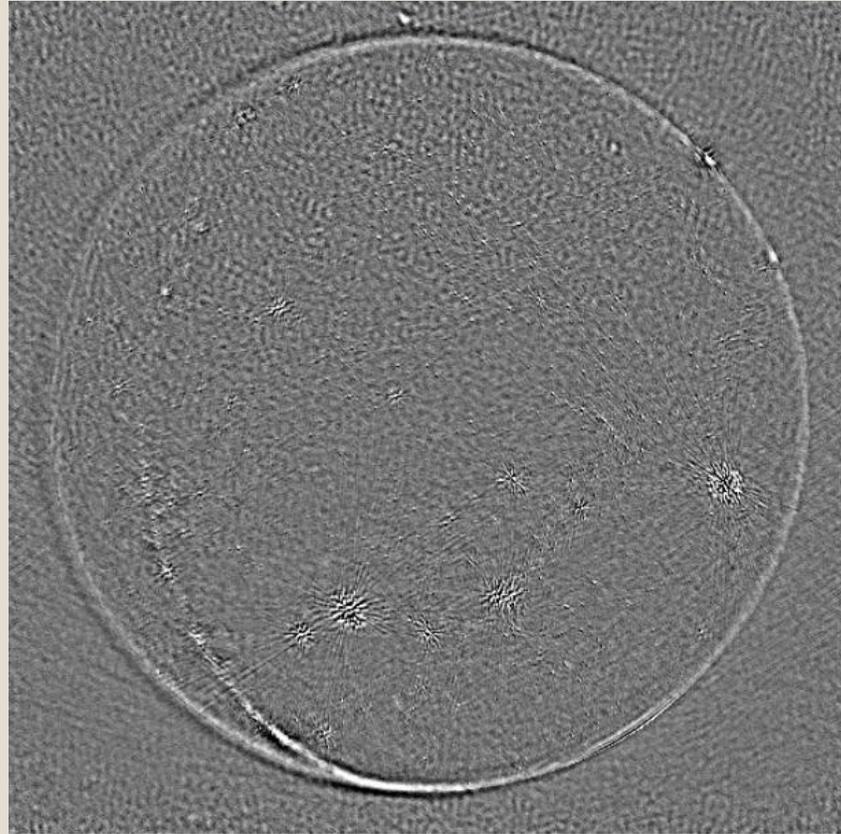
rms over Sidereally subtracted averaged images; dot is spot check with concat visibility



Sidereally subtracting longer integrations leads to **better sensitivity**



10-min image



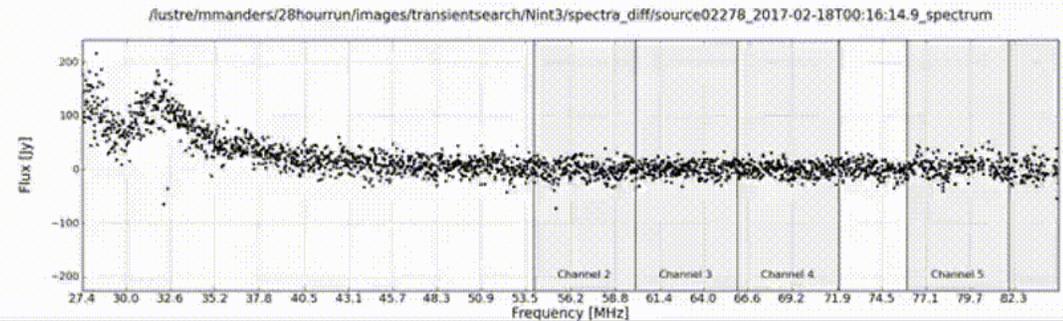
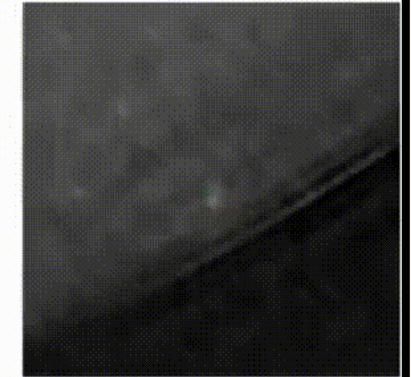
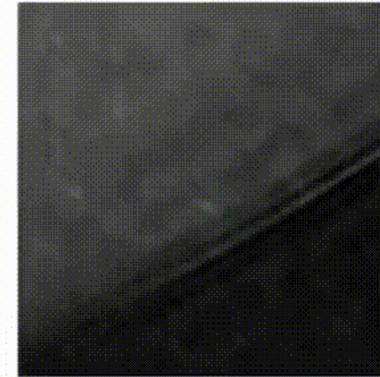
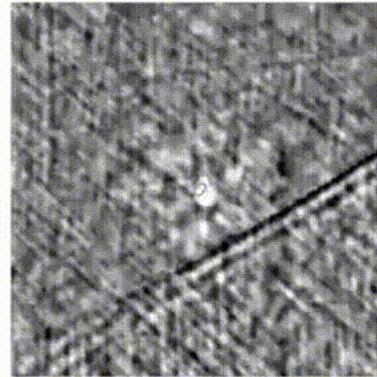
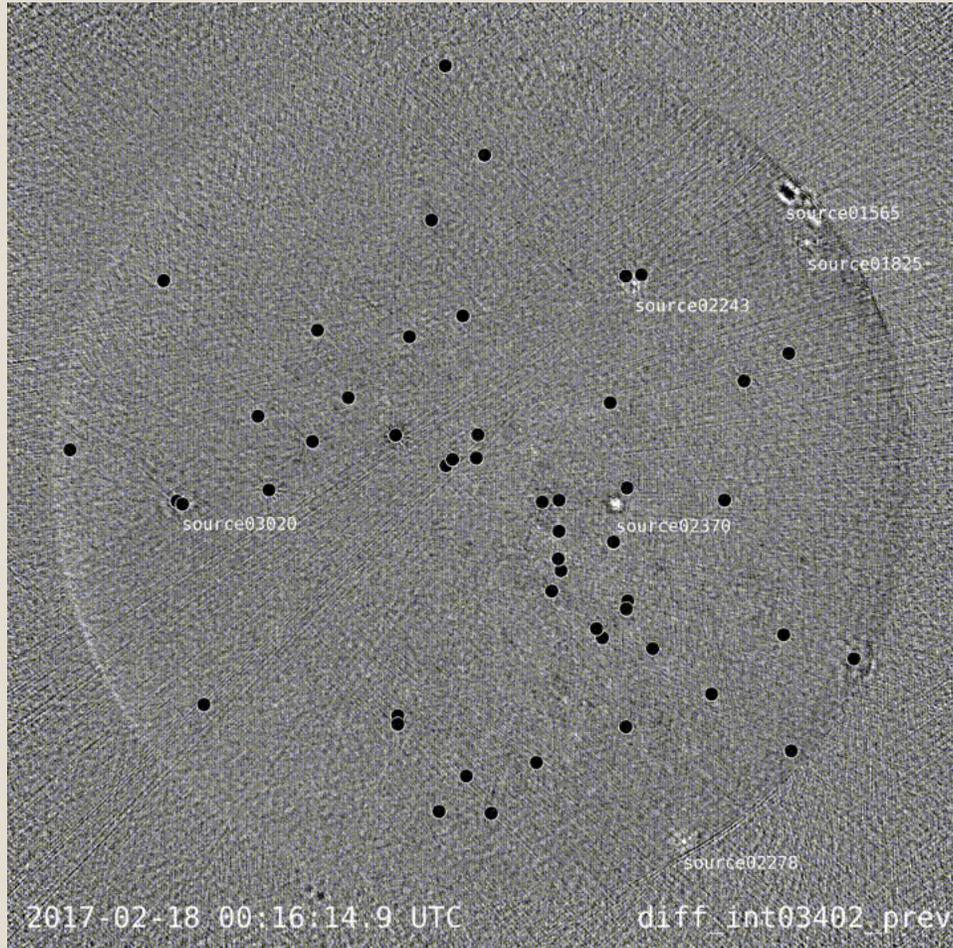
10-min subtracted
rms 250 mJy – 350 mJy

Subtracted image mean noise comparisons

Timescale/Bandwidth	Anderson+19 (31 hrs)	This work (137 hrs)
13s subsequent (57MHz)	850 mJy	850 mJy
13s sidereal (57MHz)	1.57 Jy	0.9 - 1.1 Jy
Long integration (57 MHz)	1.68 Jy in 6 minutes	250 - 400 mJy in 10 minutes
10-min (216 kHz at 60 MHz)*		1.1 Jy

*The Stewart+16 survey had bandwidth of 195kHz at 60MHz.

Broad band spectrum is useful for vetting candidates

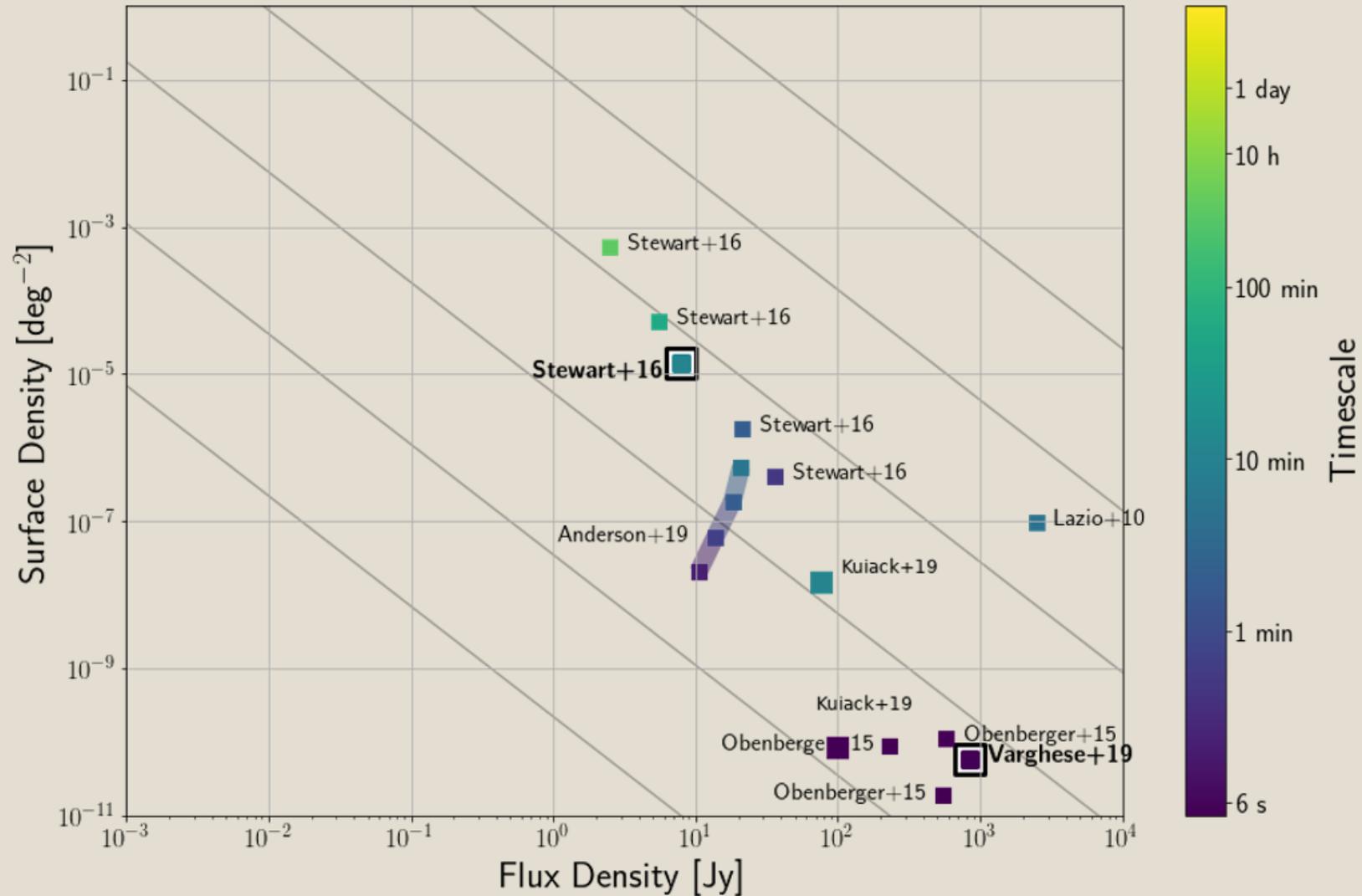


(00h00m01.1s -33d14m32.8s)
(-151.4 az 12.7 el)
(0.14deg x 0.27deg)
0.570 x unresolved
Source 02278

15.47 SNR
15.86 Jy peak flux
005 detections
Auto classification: Plane

Marin Anderson

A **sensitive** search for timescales 13s – 1day



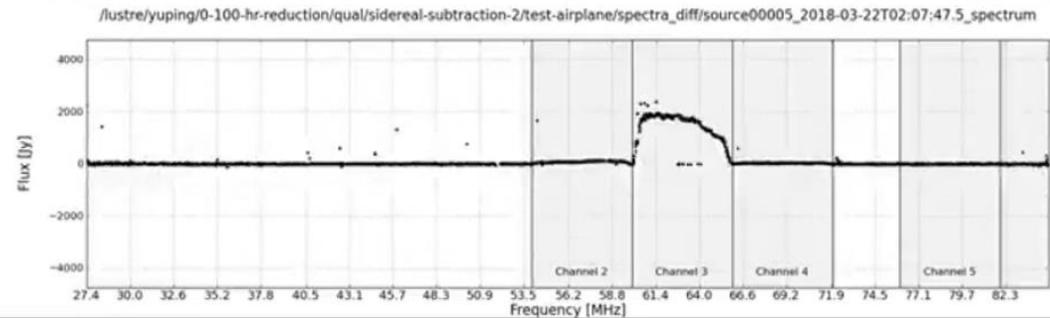
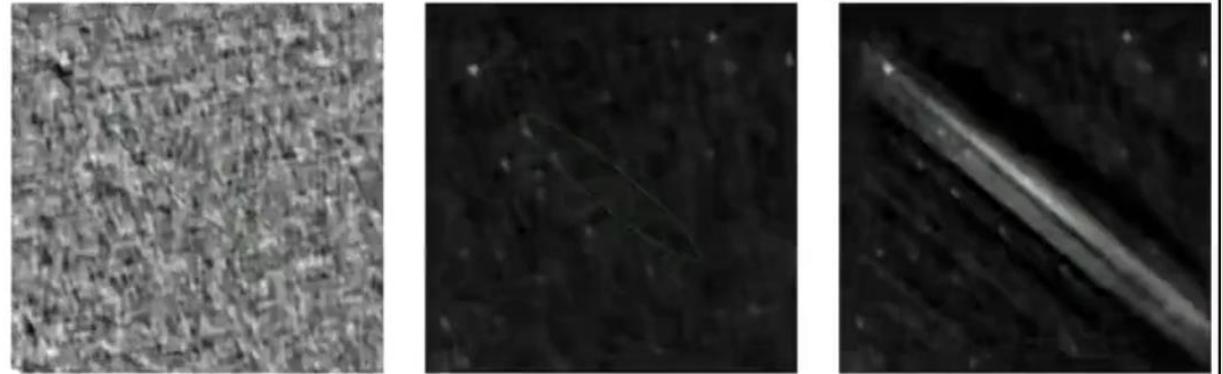
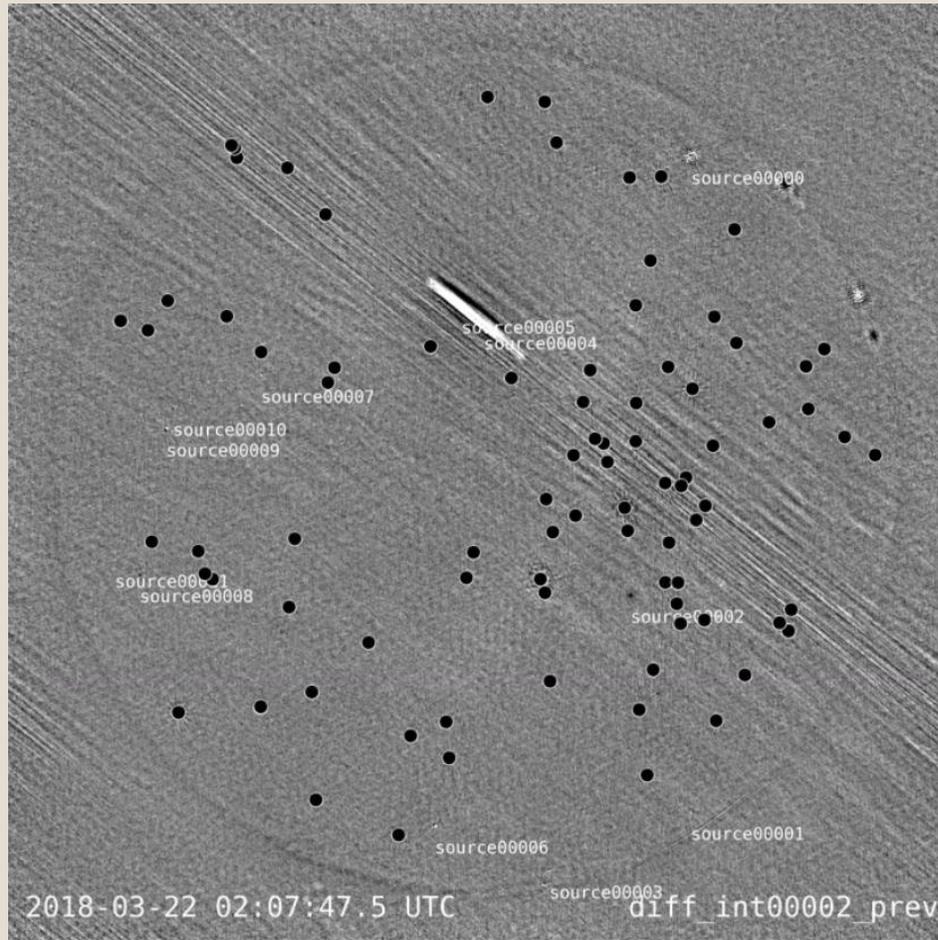
Adapted from
Anderson+19

Summary

- Transient search at $<100\text{MHz}$ is **well motivated**
- Sidereal subtraction with the OVRO-LWA enables **sensitive transient searches at timescales from 13s to 1 day**
- Sidereally subtracting **time-integrated data** leads to better sensitivity
- Stay tuned for results from the 137-hour survey
- OVRO-LWA's Stage III expansion will probe deeper in the transient parameter space!

Backup Slides

Broad band spectrum is useful for vetting candidates



(06h28m56.5s 60d09m49.3s)
(5.1 az 66.9 el)
(6.13deg x 1.04deg)
12.805 x unresolved
Source 00005

17.37 SNR
21.84 Jy peak flux
001 detections
Auto classification: Plane

From visibility to images

- 81/256 antennas and 771/30800 baselines manually flagged
- Channel RFI flags are automated
- Direction-independent (DI) calibration on CasA + CygA + Sun stable over ~24 hours
- Peeling on CasA and CygA
- Flags for subtraction pairs merged, then imaged with Briggs weighting `robust=0`
- Workflow migrated to Celery on RabbitMQ on a 10-node cluster