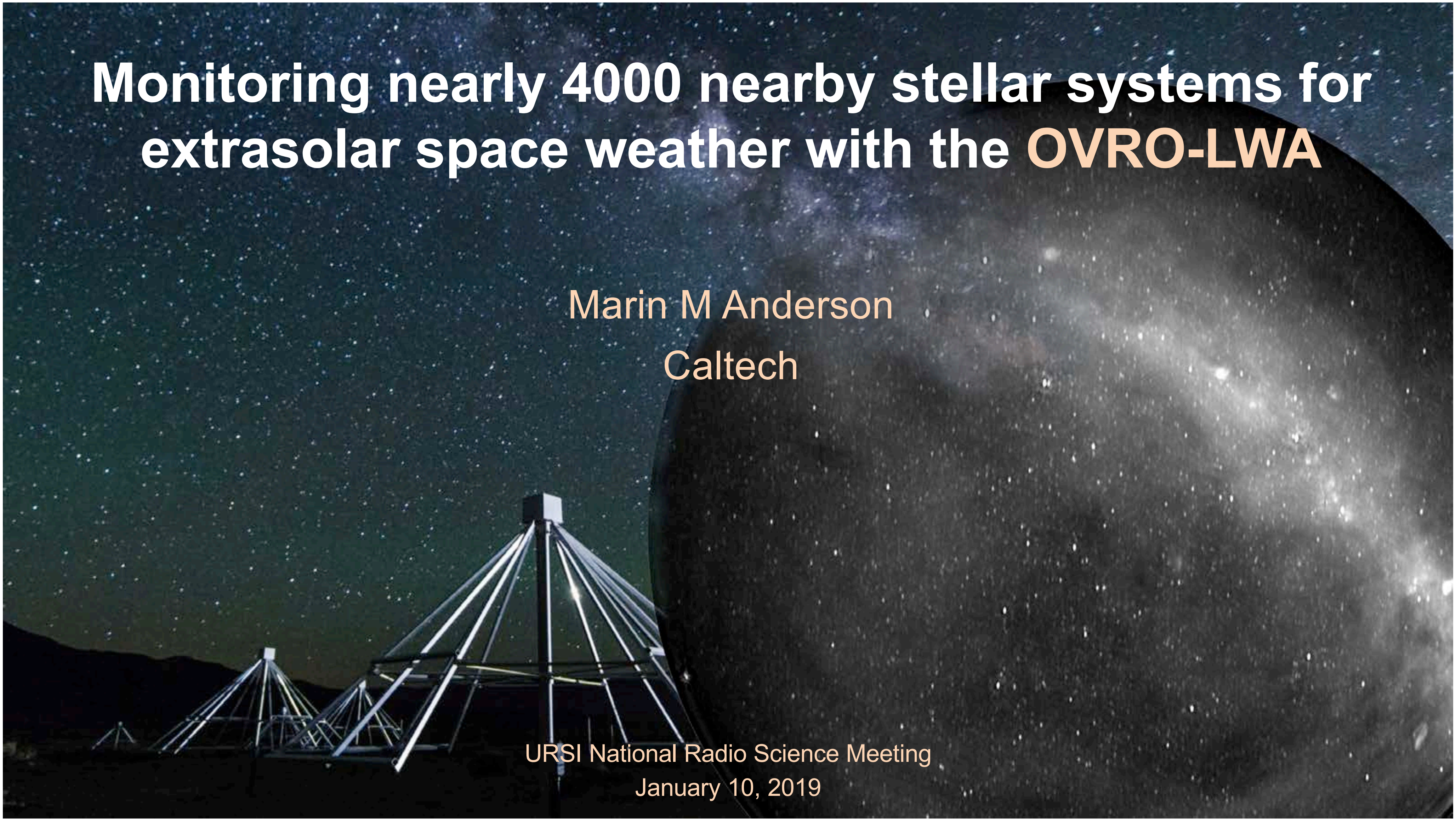


Monitoring nearly 4000 nearby stellar systems for extrasolar space weather with the OVRO-LWA

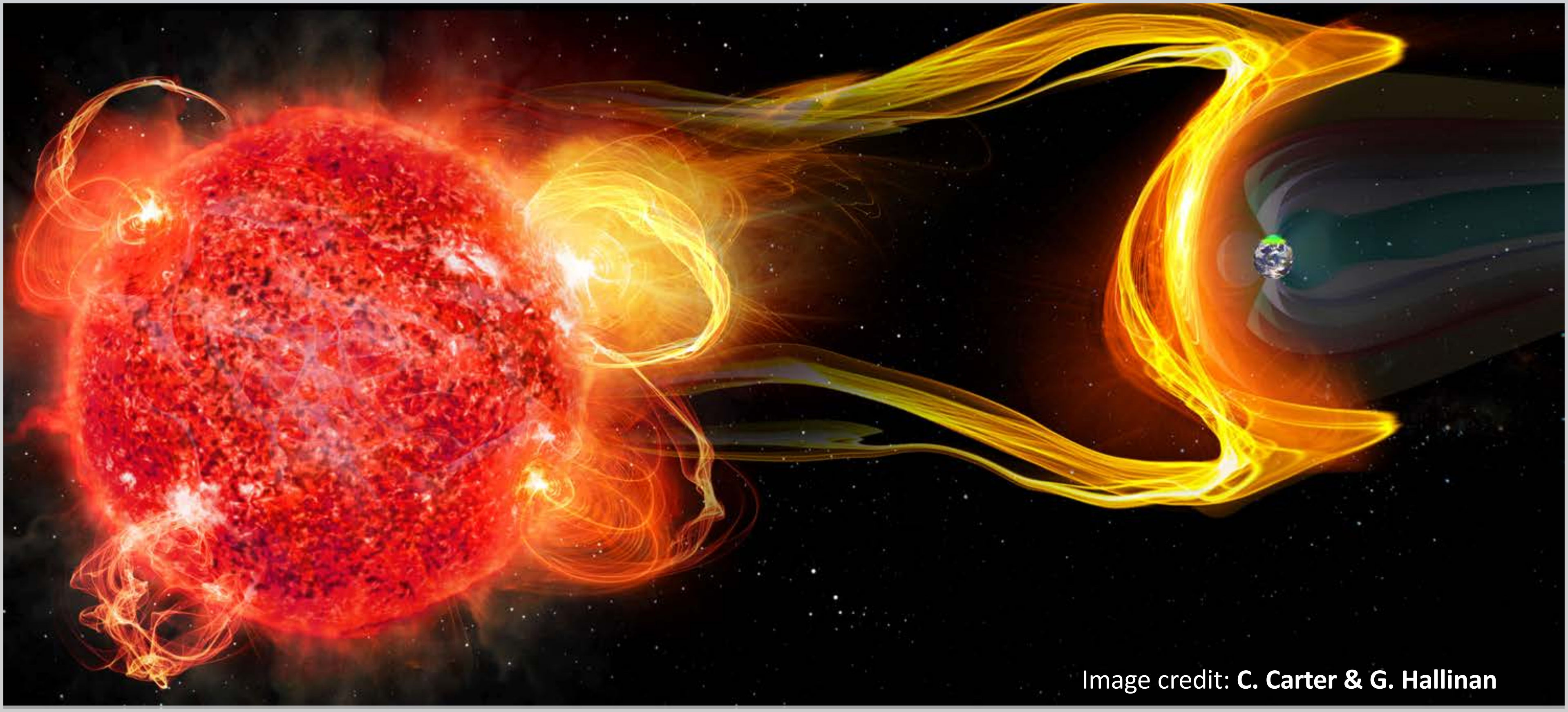
Marin M Anderson

Caltech

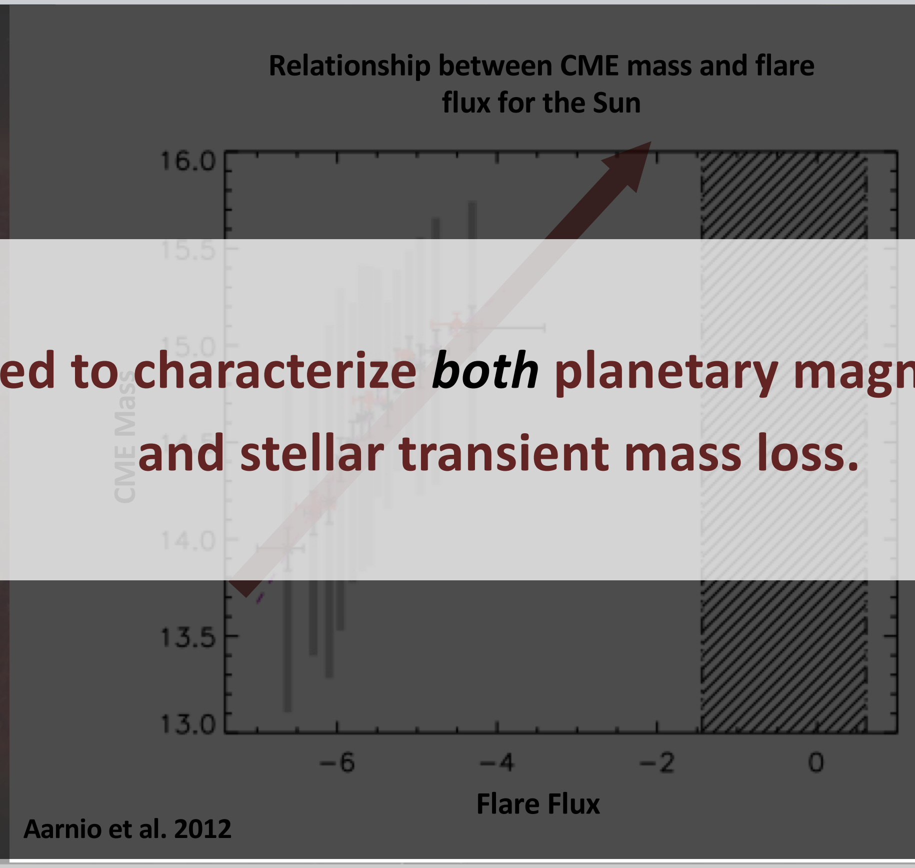
URSI National Radio Science Meeting

January 10, 2019

Characterizing stellar magnetic activity, planetary magnetic fields, and their interaction for a wide range of host mass and age.

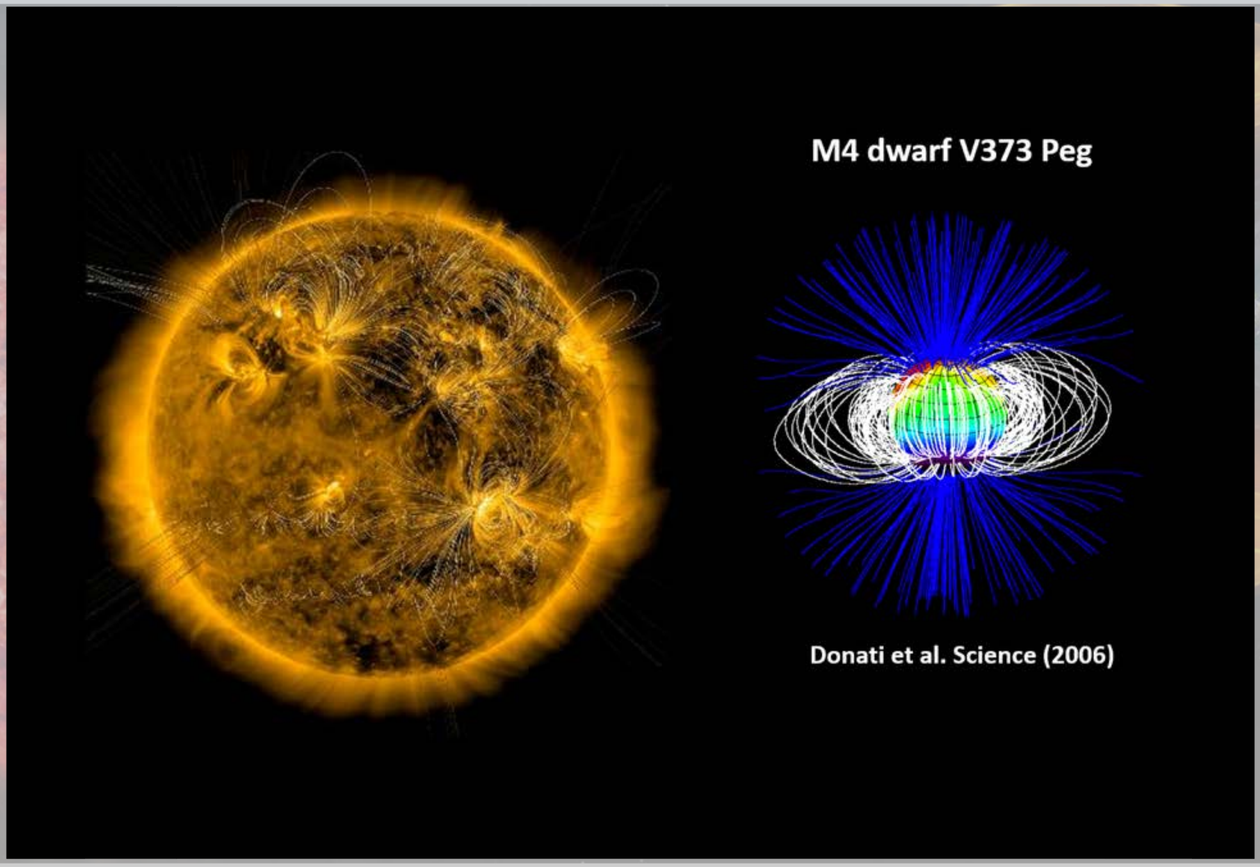


Understanding how CMEs scale with flare energy and frequency is critical to diagnosing habitable environments around magnetically active stars.



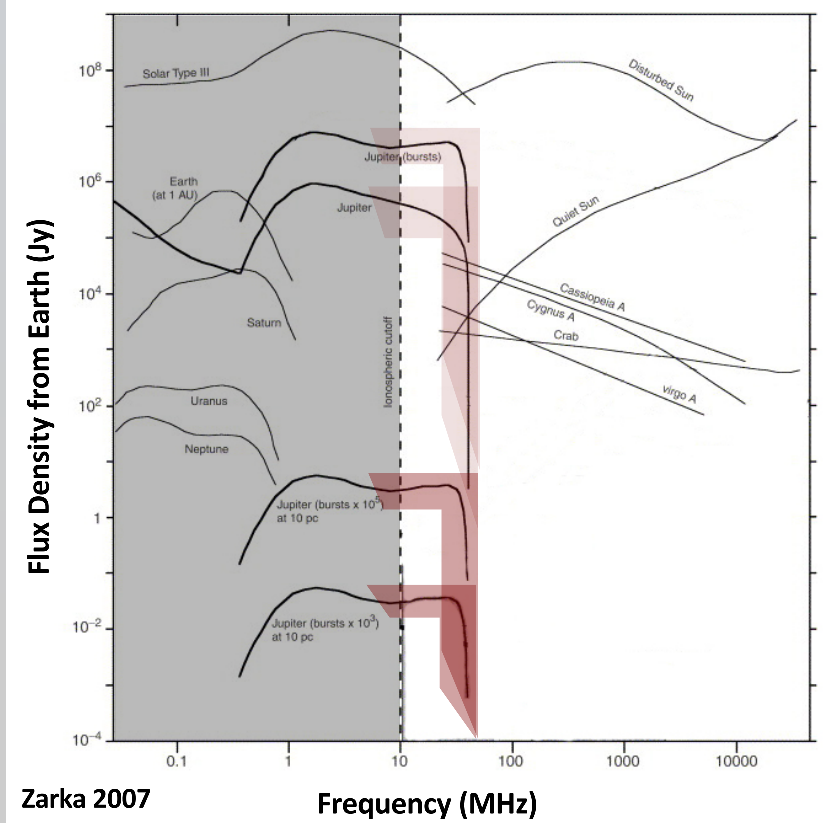
We need to characterize *both* planetary magnetic fields and stellar transient mass loss.

And understanding how CME mass, morphology, and velocity scale with magnetic field strength and topology.



Low frequency (< 100 MHz)

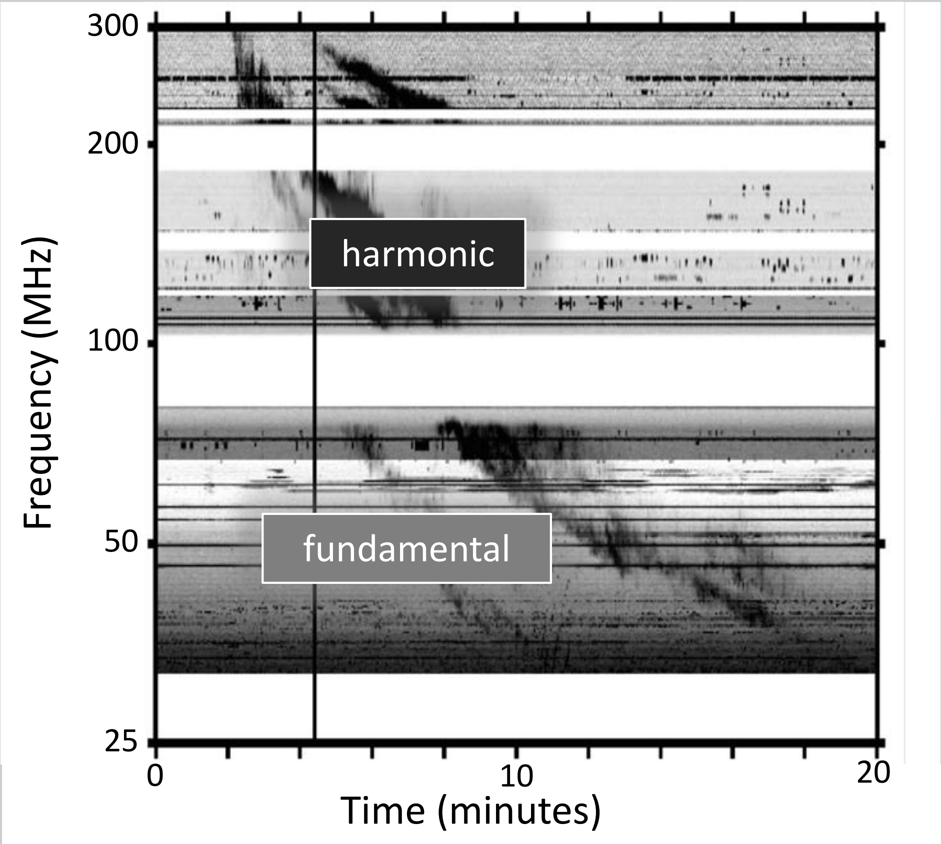
- Extrapolation from our own SS suggests it is necessary to go below 100 MHz to directly detect exoplanetary radio emission.



Zarka 2007

Low frequency (< 100 MHz)

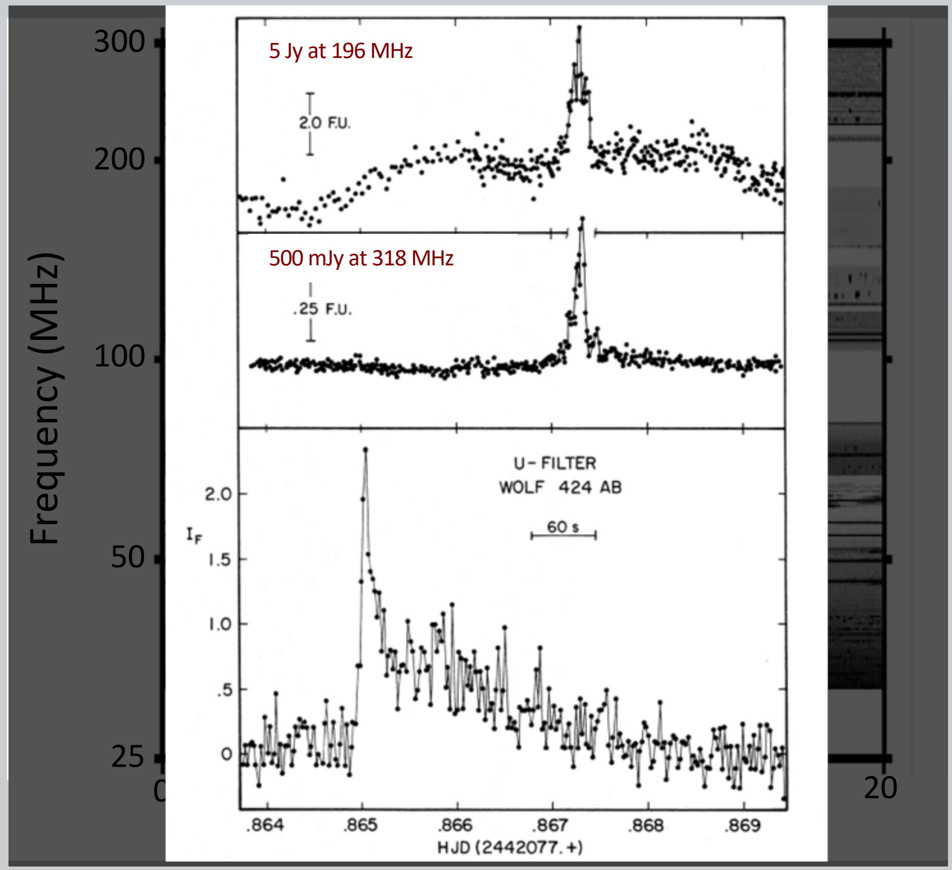
- Extrapolation from our own SS suggests it is necessary to go below 100 MHz to directly detect exoplanetary radio emission.
- Solar Type II radio bursts are associated with CMEs, and frequently occur in the sub-100 MHz regime.



Kouloumvakos et al. 2014
Figure c/o J. Villadsen

Low frequency (< 100 MHz)

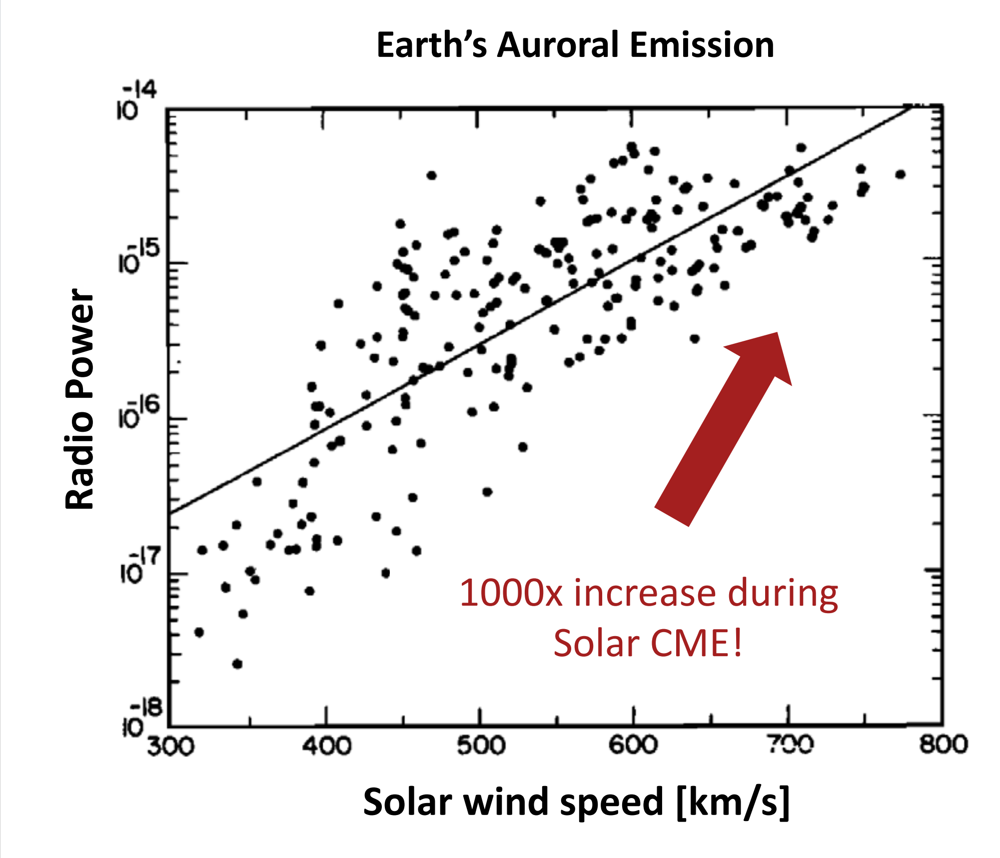
- Extrapolation from our own SS suggests it is necessary to go below 100 MHz to directly detect exoplanetary radio emission.
- Solar Type II radio bursts are frequently associated with CMEs, and peak in the sub-100 MHz regime.
- Previous detections of flare star radio emission indicate flux increases at low frequencies.



Spangler & Moffett 1976

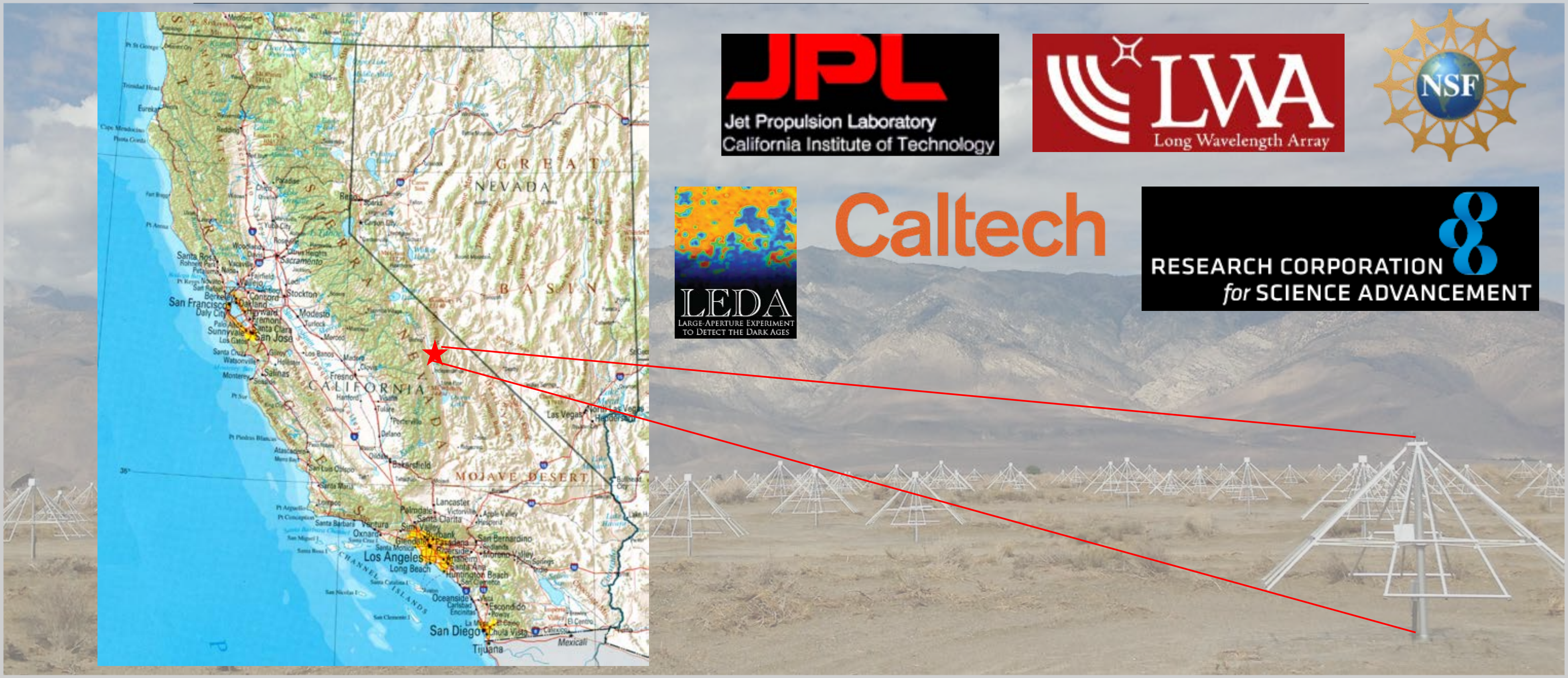
Large-FoV Instruments

- Capture a large fraction of sky in order to monitor a large sample of objects.
- Sensitive to rare events associated with extreme flares / CMEs that may induce significant increase in exoplanetary radio power.



Gallagher and D'Angelo 1981

The Owens Valley Radio Observatory Long Wavelength Array (OVRO-LWA)



Stage I of the array was completed in 2014

1

- 256 crossed-
- Spread out a
  m diameter

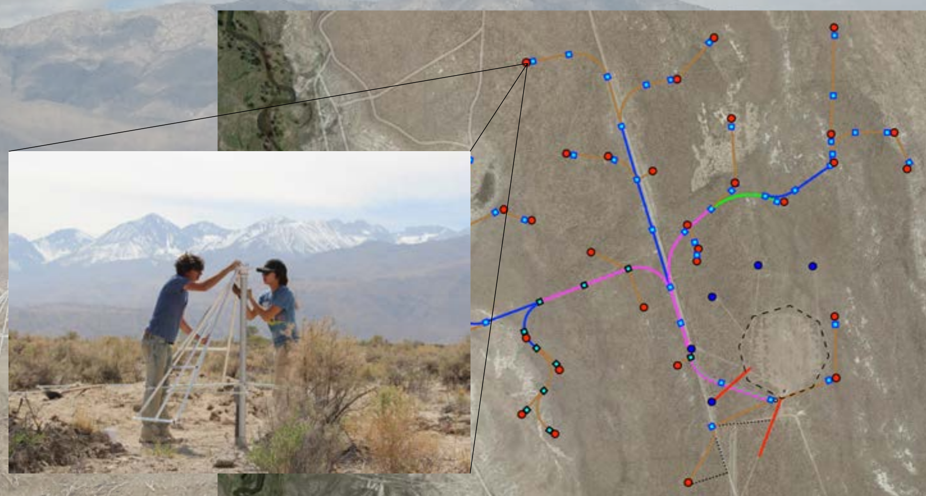
Stage II (and current status) of the array was completed in 2016

1

- 256 crossed-dipoles
- Spread out across 200-m diameter core

2

- Added 32 additional dipoles
- Increased maximum baseline out to ~1.5-km

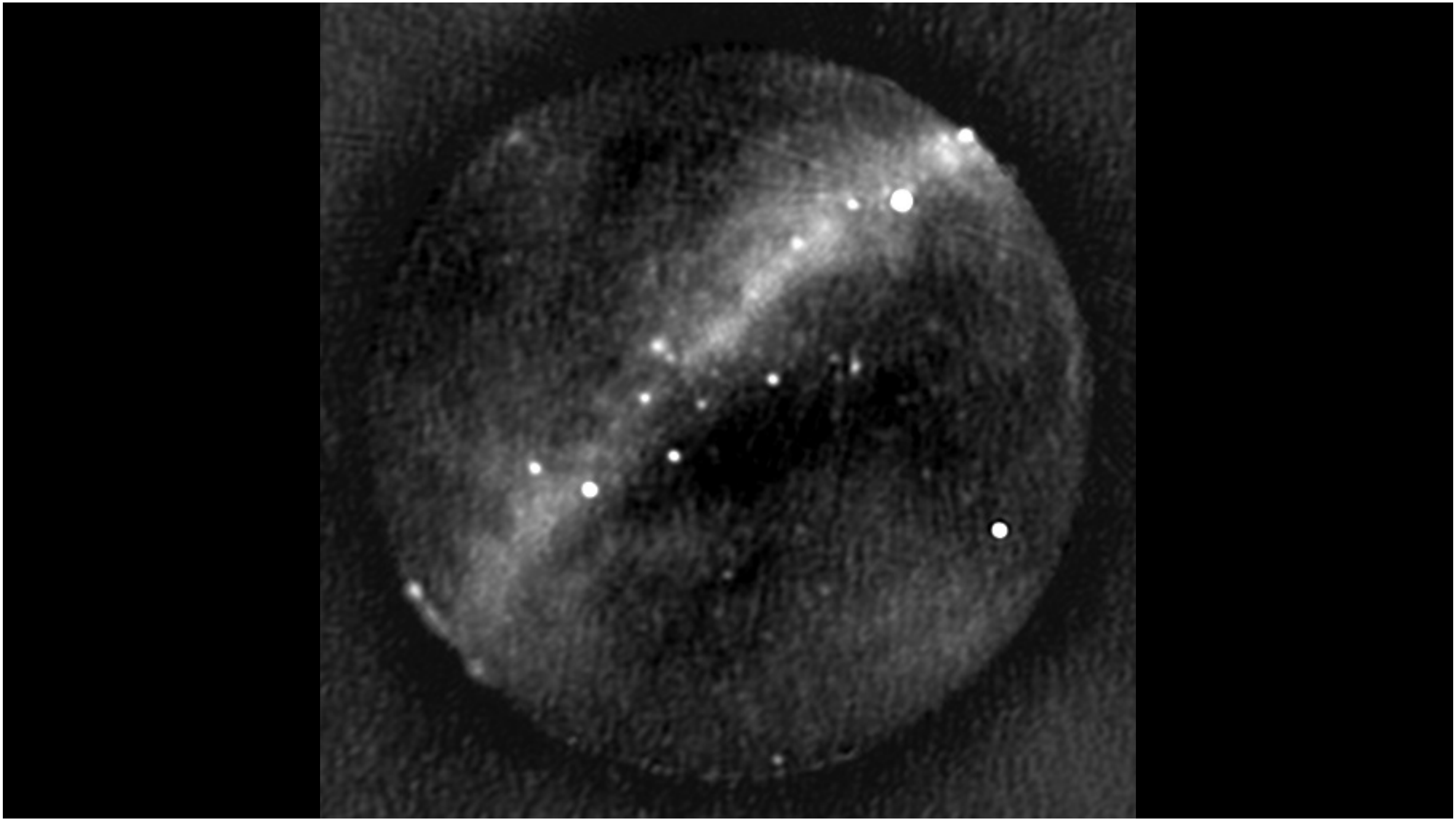


(The final) Stage III of the array will add an additional 64 antennas on long baselines, and vastly increase the capabilities of the existing OVRO-LWA.

1
- 256 crossed-dipoles
- Spread out across 200-m diameter core

2
- Added 32 additional dipoles
- Increased maximum baseline out to ~1.5-km

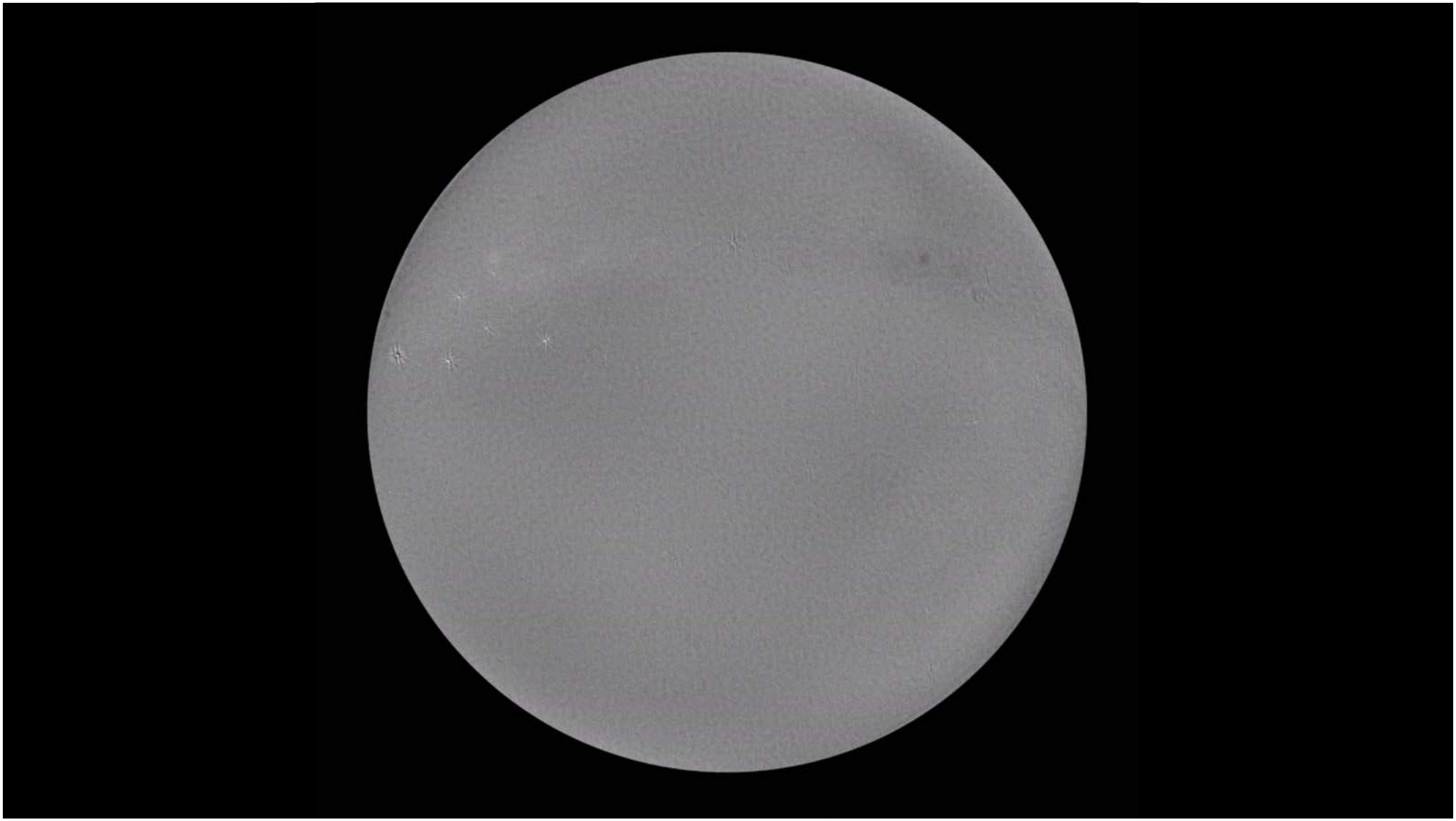
3
- Final array of 352 antennas
- New correlator for 704 inputs

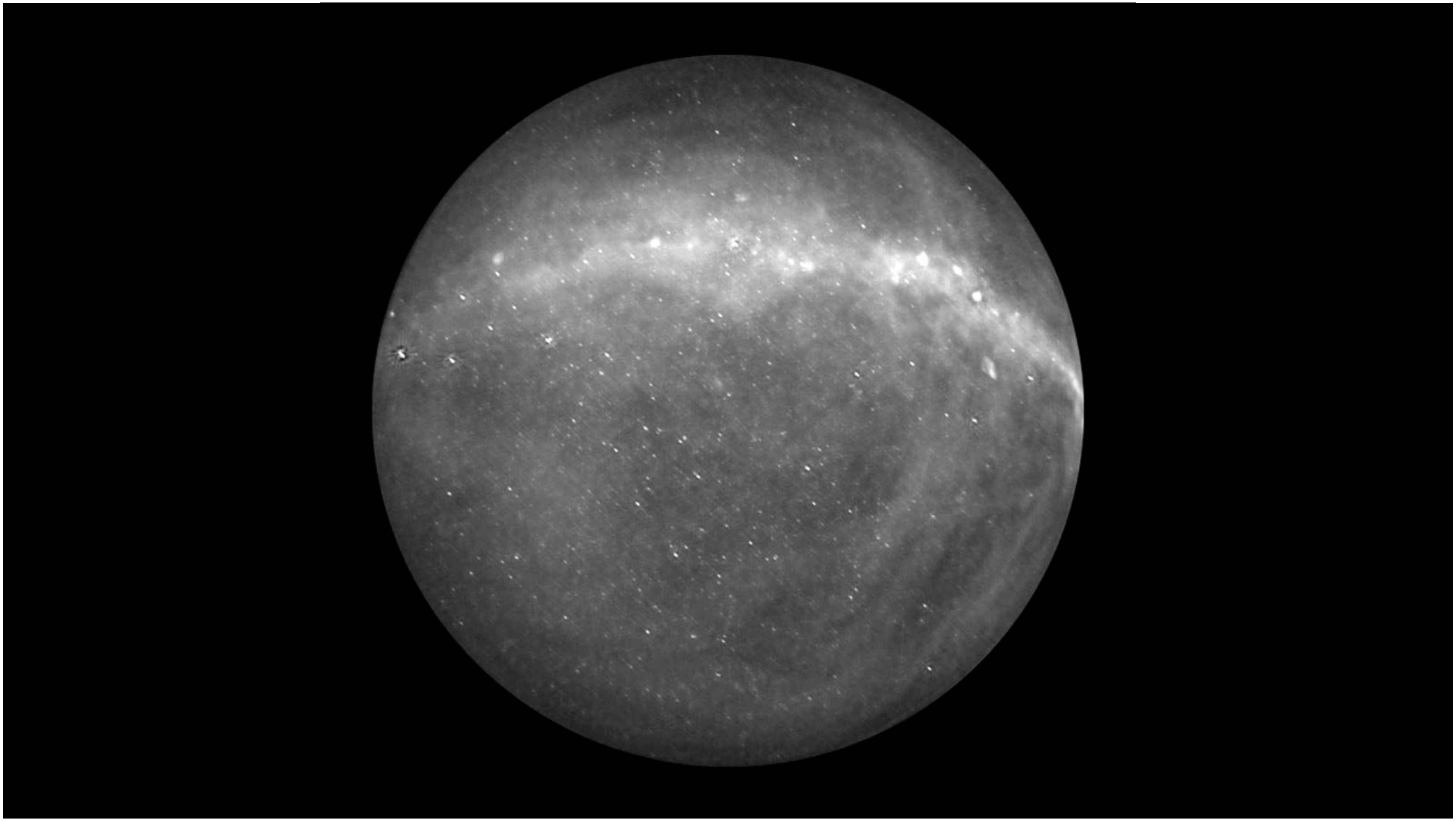


Current mode of operation with the Stage 2 OVRO-LWA

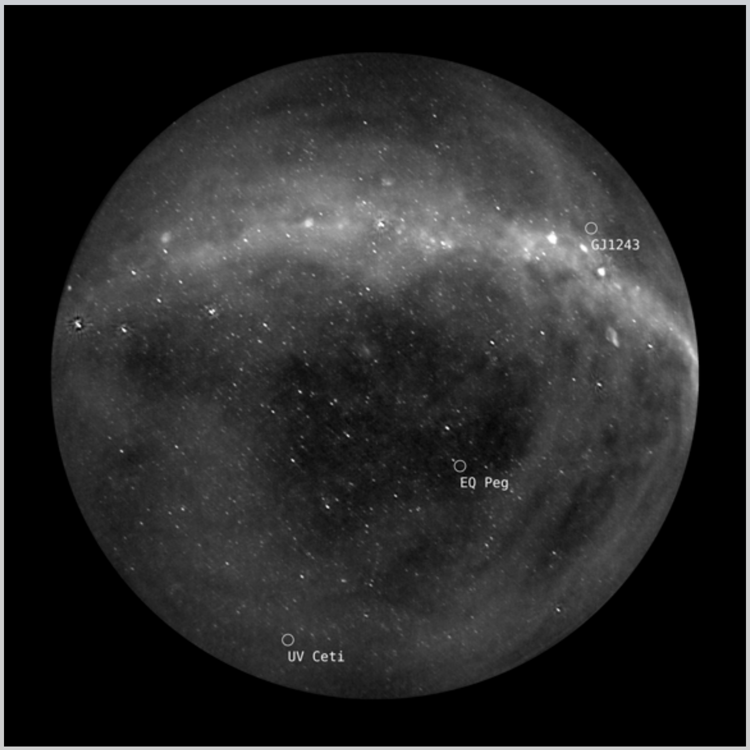
- Continuously observing as of November 2016, in order to respond to external event triggers (including GW events from aLIGO, X-ray flares from *Swift*).

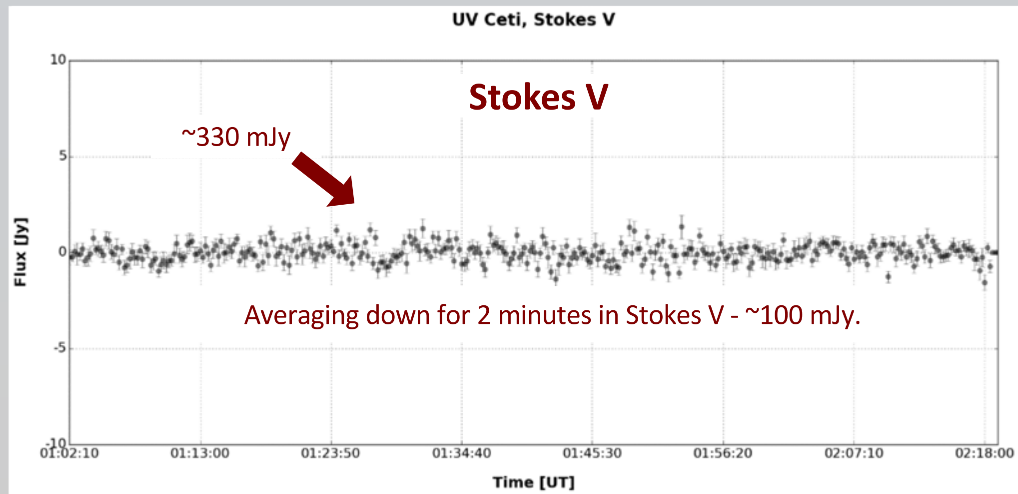
- Initial 28-hour dataset monitoring 4000 objects out to 25 pc.
- 27-84 MHz with 24 kHz resolution
- 13-second integrations



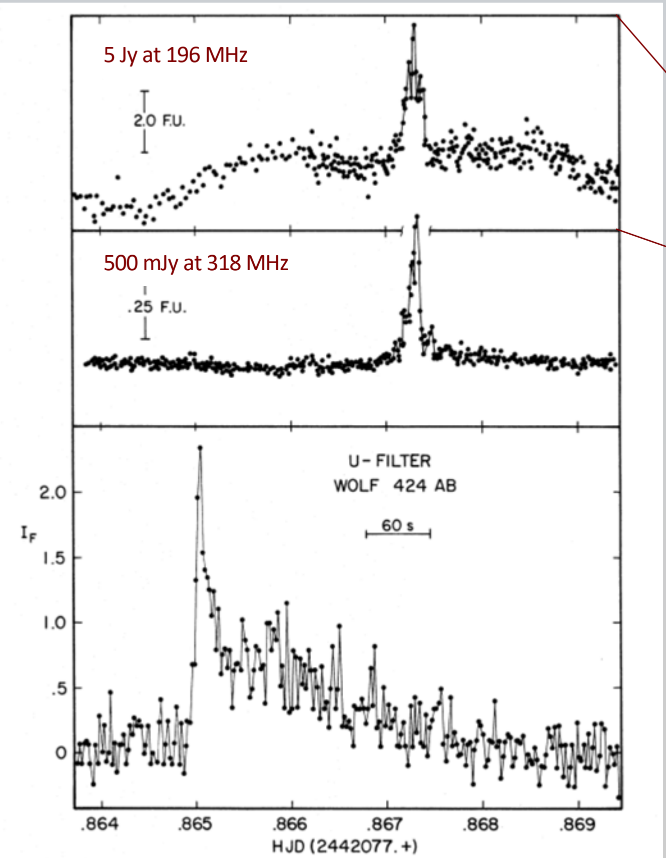


Initial results from a sample subset of flare stars.

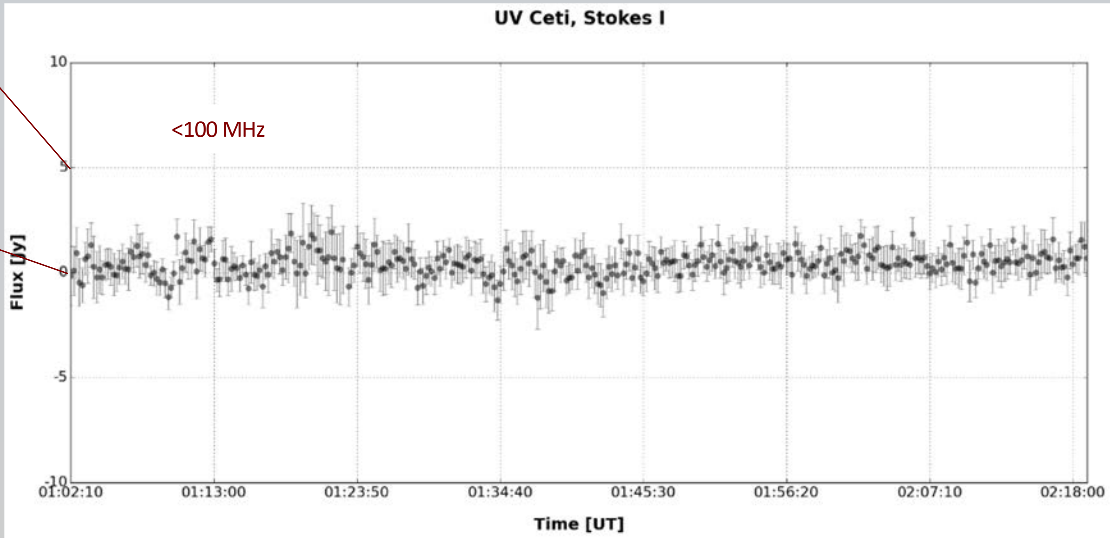




OVRO-LWA light curves for the usual flare star suspects.

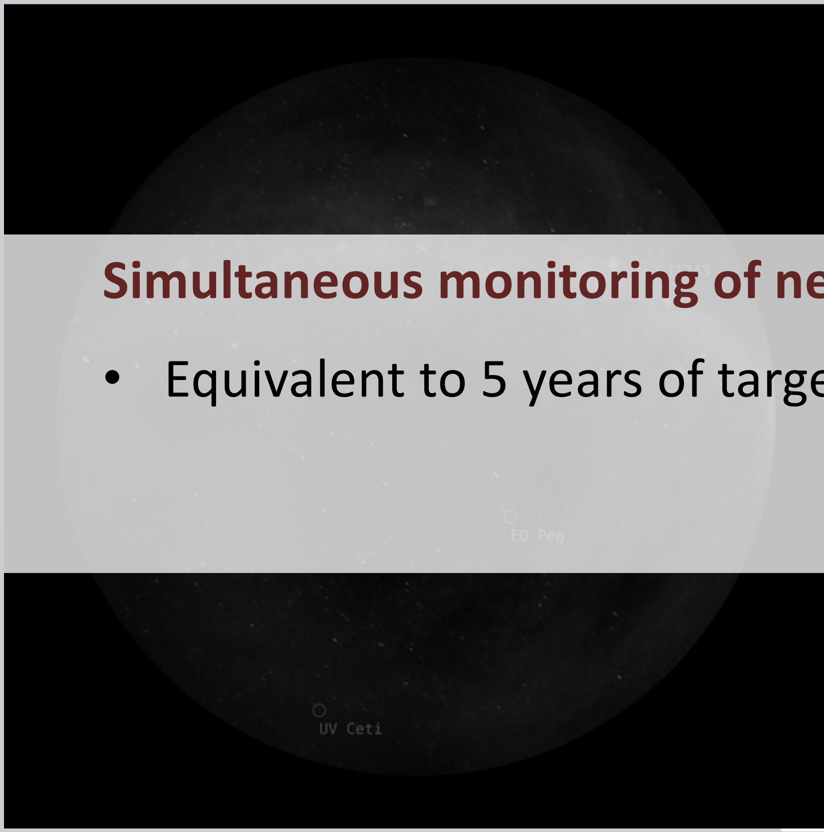


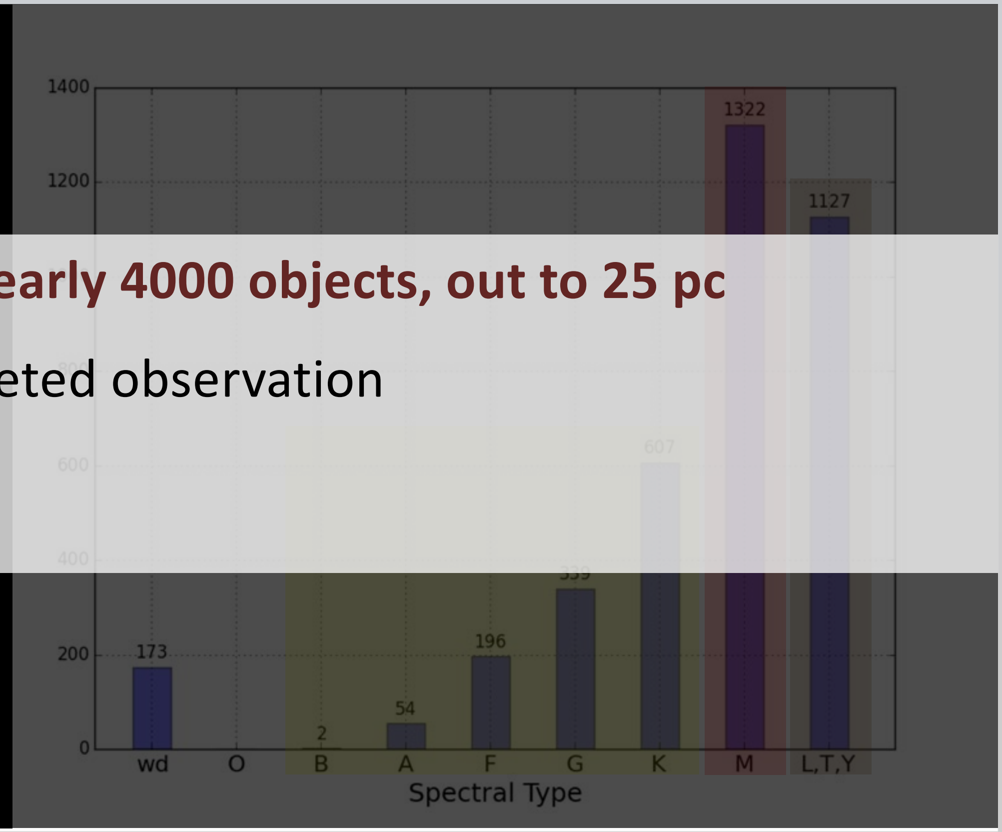
Spangler & Moffett 1976



- A Wolf 424-like flare would be >10 σ detection!

Searching for signatures of magnetic activity in a volume-limited sample of systems.

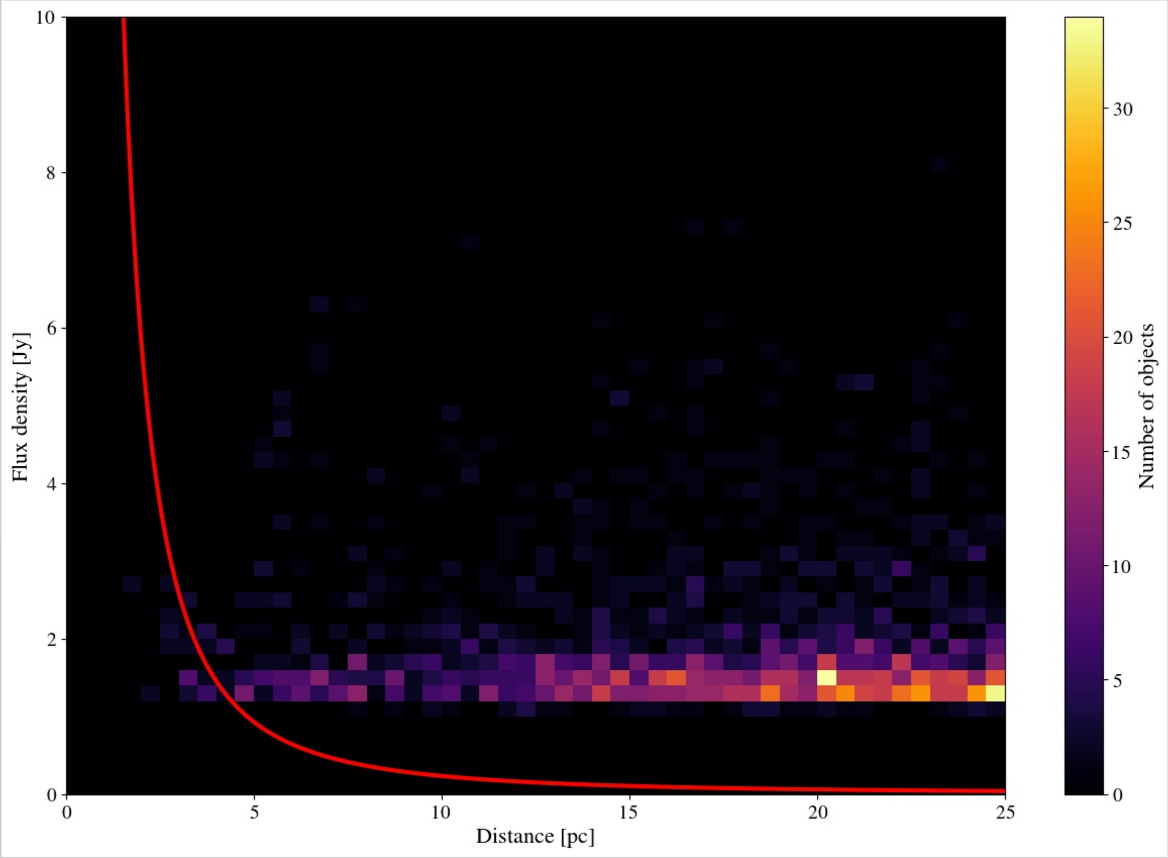




Simultaneous monitoring of nearly 4000 objects, out to 25 pc

- Equivalent to 5 years of targeted observation

Sensitivities achieved for all objects in the 28-hour survey.



OVRO-LWA

Scientific goals of the OVRO-LWA

- Establish flare and CME rates across a wide range of mass and age.
- Investigate the relationship between flare energy and CME kinetic energies for low mass stars.
- Inform the community of extreme events.
- Receive triggers for highest energy events (e.g. *Swift* super-flares).
- Provide the most meaningful constraints (or detections) of radio exoplanets.