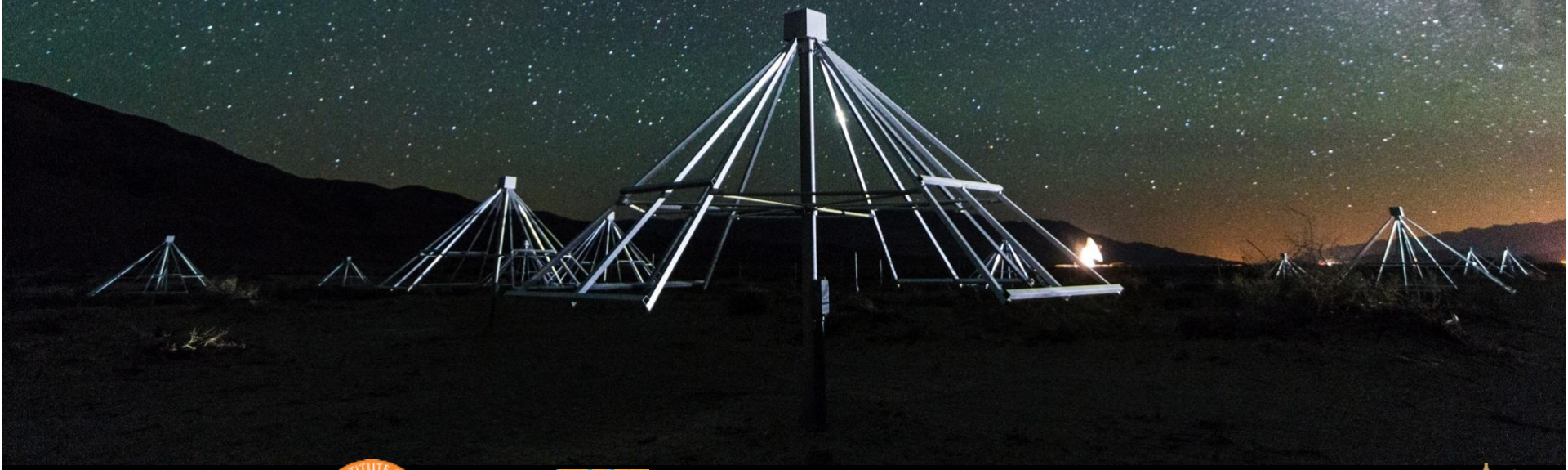
The Owens Valley LWA

Gregg Hallinan: Caltech

E-mail: *gh@astro.caltech.edu*



RESEARCH CORPORATION *for* SCIENCE ADVANCEMENT

CALIFORNIA INSTITUTE OF TECHNOLOGY 1891

LEDA
LARGE-APERTURE EXPERIMENT TO DETECT THE DARK AGES

JPL
Jet Propulsion Laboratory
California Institute of Technology

NJIT
New Jersey Institute of Technology

LWA
Long Wavelength Array

NSF

Collaboration

- **Caltech, OVRO & JPL:**
- **Gregg Hallinan, Stephen Bourke, Michael Eastwood, Marin Anderson, Ryan Monroe, Harish Vedantham, Sandy Weinreb, David Wang, Michael Huynh, Esayas Shume, Kate Clark**

- **David Woody, James Lamb + OVRO staff**

- **Joe Lazio, Larry D'Addario, Jonathon Kocz, Dave Hawkins, Attila Komjathy, Melissa Soriano, Andrew Romero-Wolf, Paul Ries**

- **LWA Collaboration: Greg Taylor, Joe Craig, Namir Kassim, Brian Hicks, Frank Schinzel, Steve Ellingson et al.**

- **LEDA Collaboration: Lincoln Greenhill, Danny Price, Ben Barsdell, Hugh Garsden, Frank Schinzel, Greg Taylor, Dan Werthimer, Steve Ellingson et al.**

- **NJIT Solar: Dale Gary, Bin Chen, Sijie Yu, Sherry Chhabra**

Concept

352 antennas spaced over ~2.6 km

Full cross-correlation = All-sky FOV

25-85 MHz (2400 channels)

5 arcminute resolution

Science with All-sky FoV

Transients (Stellar CMES and Extrasolar Planets)

Cosmic Dawn

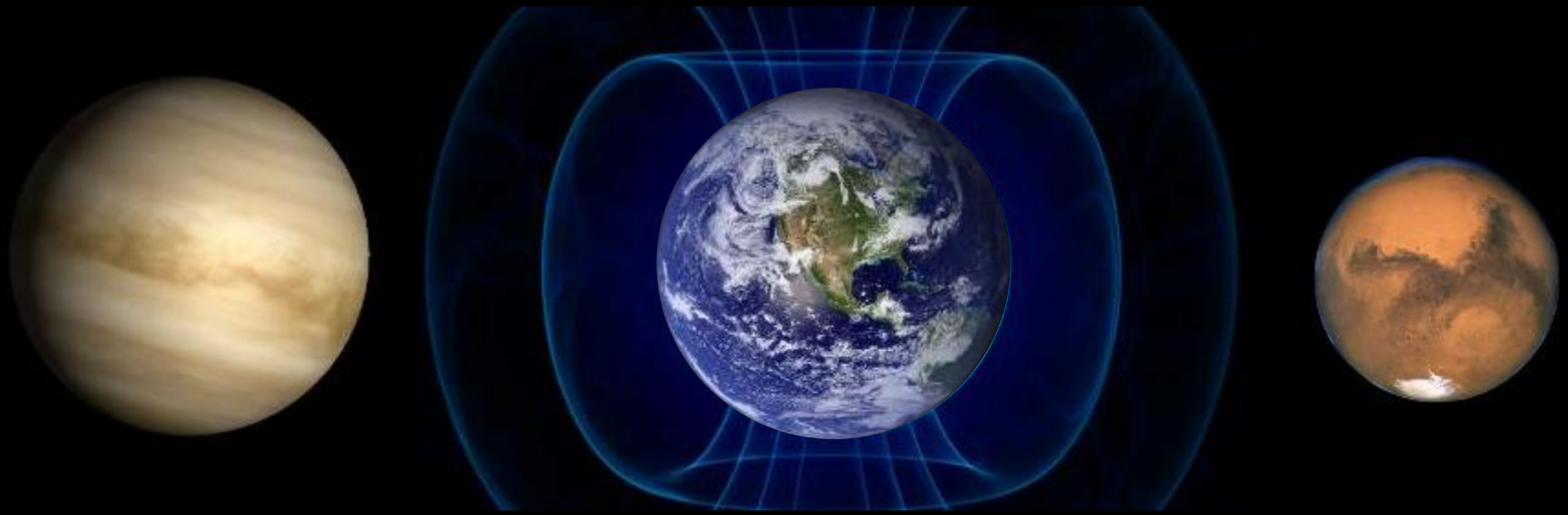
Monitoring of the Sun and Jovian System

Ionospheric Monitoring


A fertility company that defies the textbooks p. 629
Multigenerational effects on development pp. 634 & 651
Microbial ecology and evolution pp. 649 & 663
Science
$10
6 NOVEMBER 2015
sciencemag.org
AAAS
MAVEN at Mars
Probing a dynamic upper atmosphere p. 643

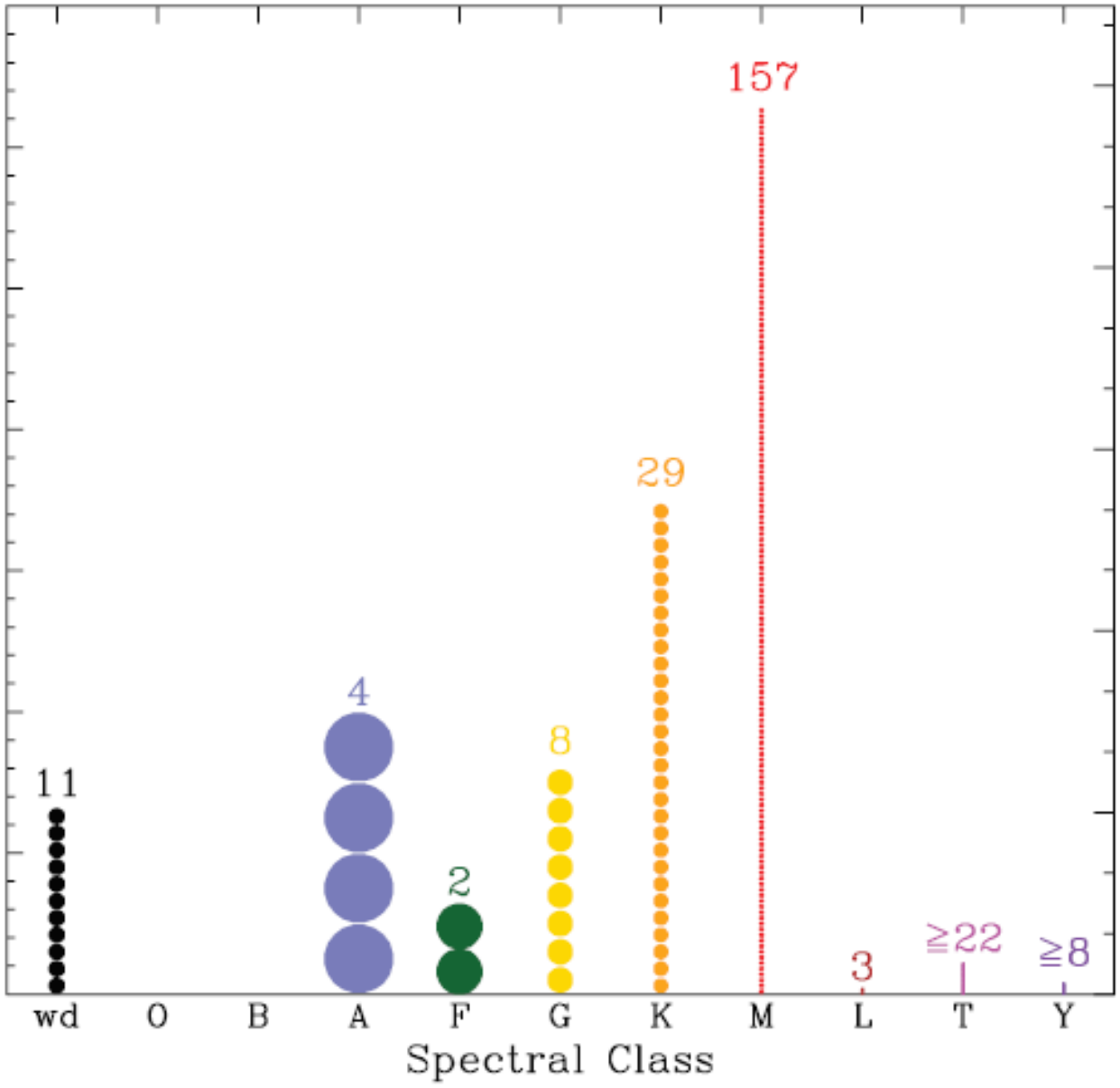
>3000 planets detected…

Is magnetic activity important for defining habitability?
Can we directly detect CMEs, planetary aurorae?



Magnetic activity can redefine habitability!

Stars out to 8 pc

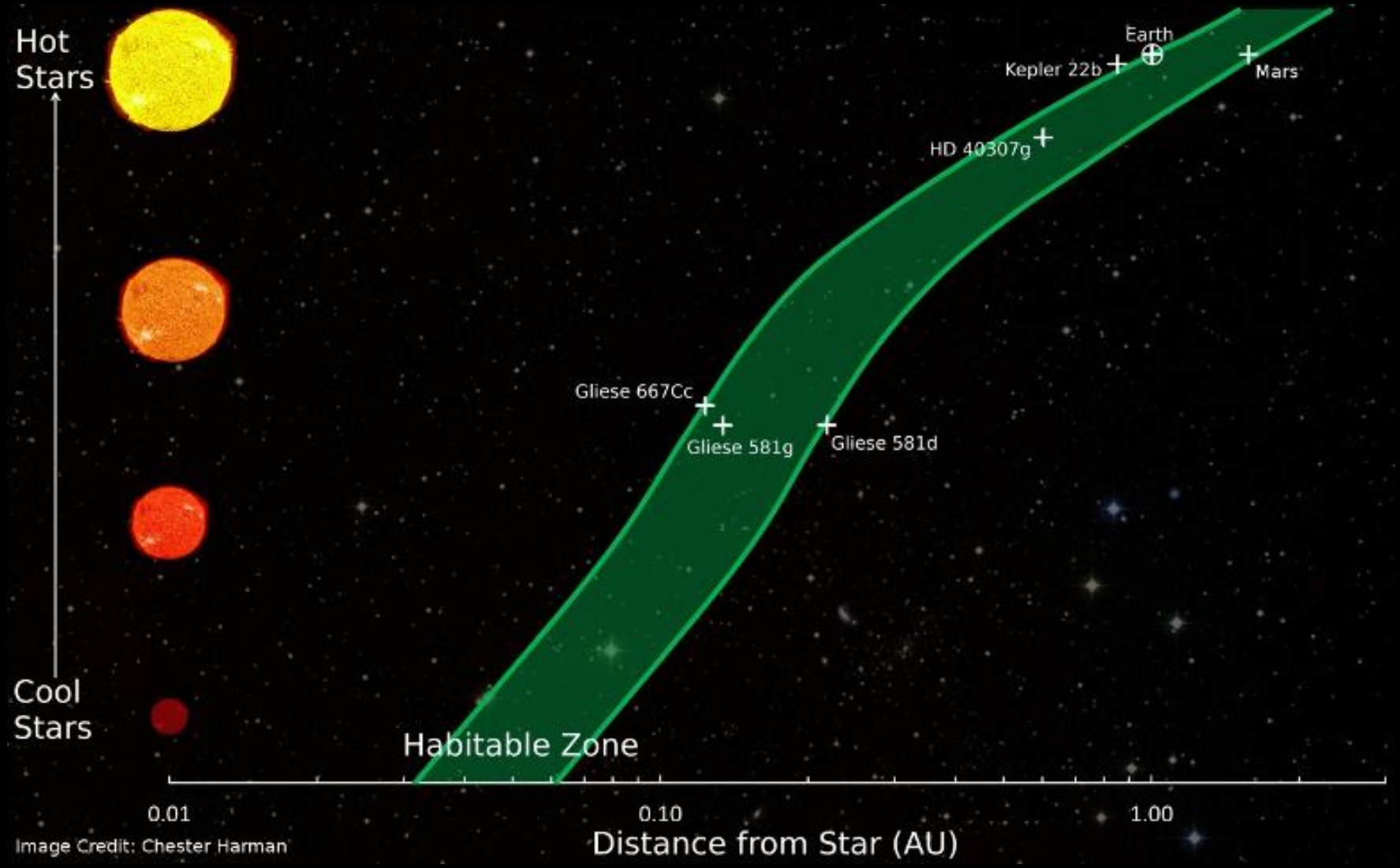


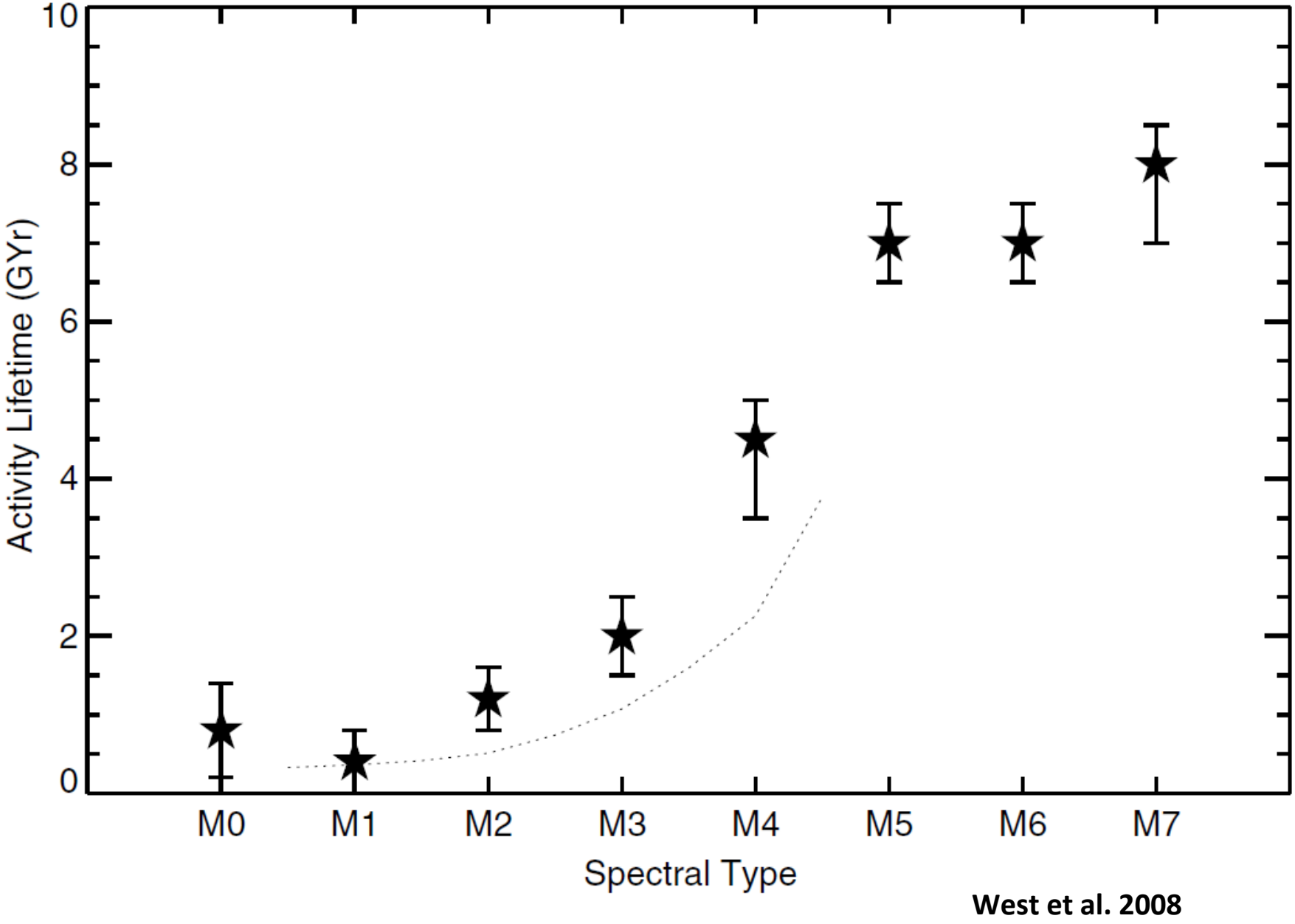
Kirkpatrick et al. 2012

95% of stars that can host evolved exoplanets (age > 1 Gyr) are M dwarfs

Rocky planets are frequent around M dwarfs (Dressing & Charbonneau 2013, 2015)

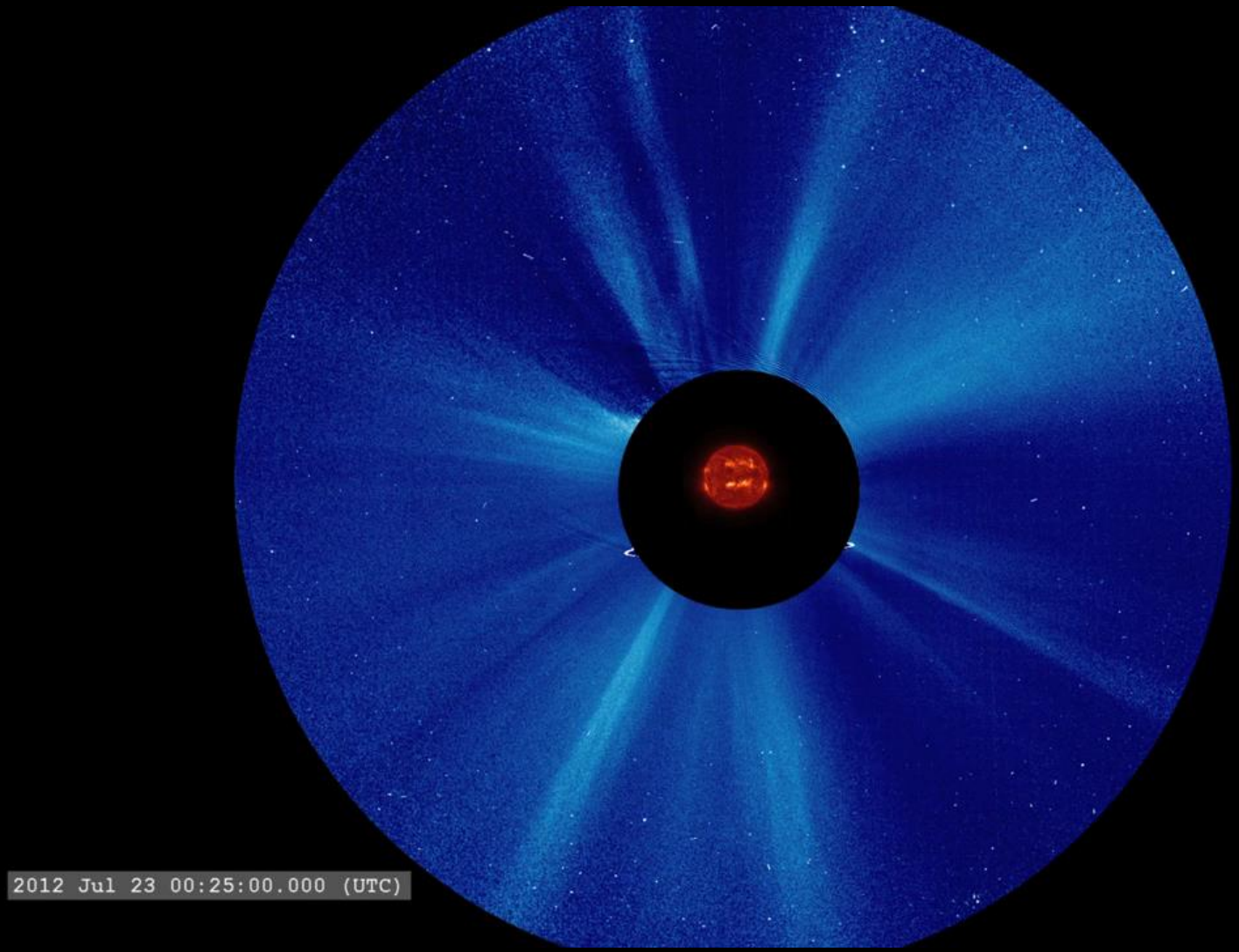
The nearest habitable planet orbits an M dwarf at 2.6 +/- 0.4 pc!


Hot
Stars
Cool
Stars
Earth
Kepler 22b
Mars
HD 40307g
Gliese 667Cc
Gliese 581g
Gliese 581d
Habitable Zone
0.01
0.10
1.00
Distance from Star (AU)
Image Credit: Chester Harman



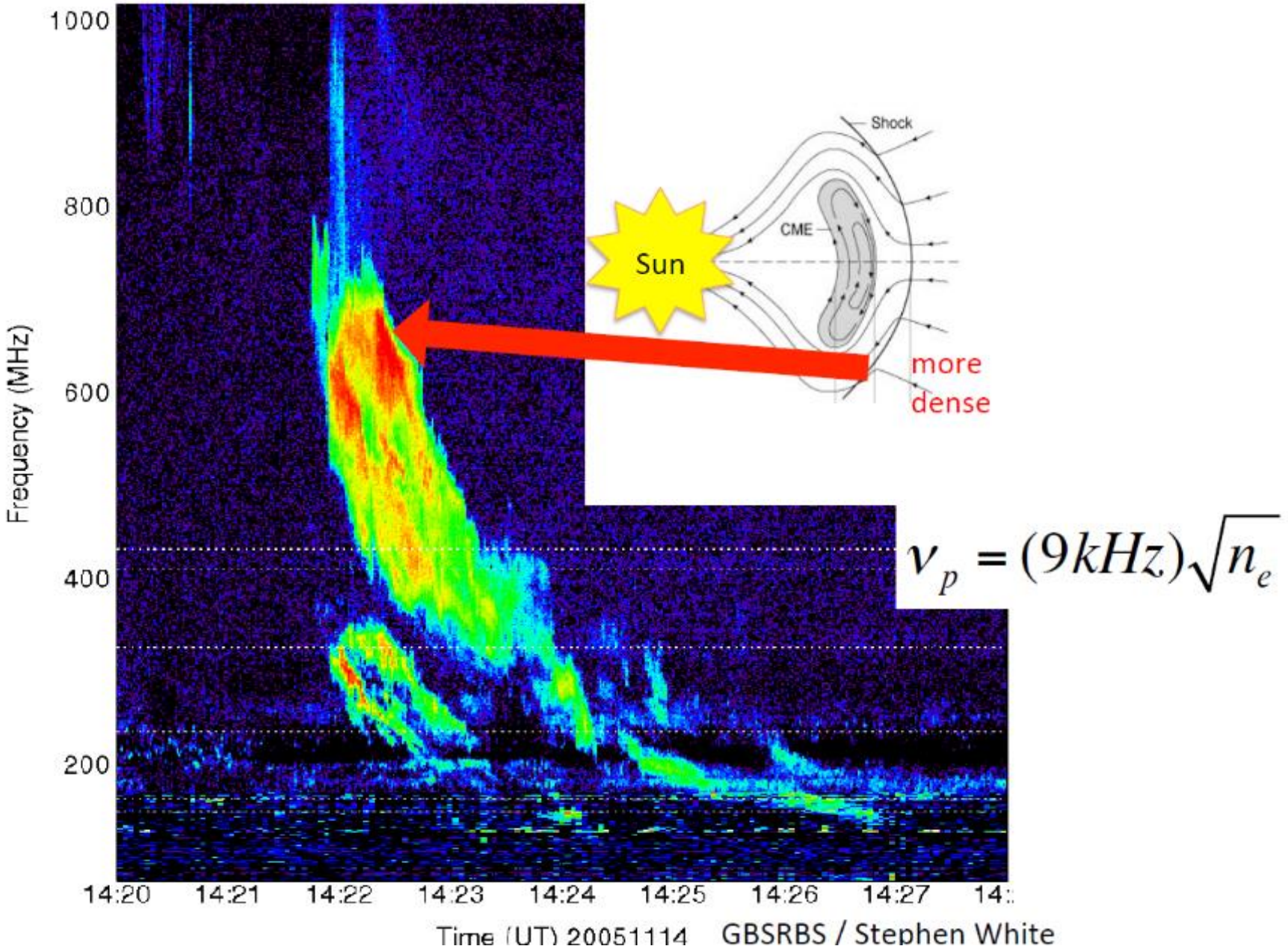
West et al. 2008

Remote Sensing of CMEs

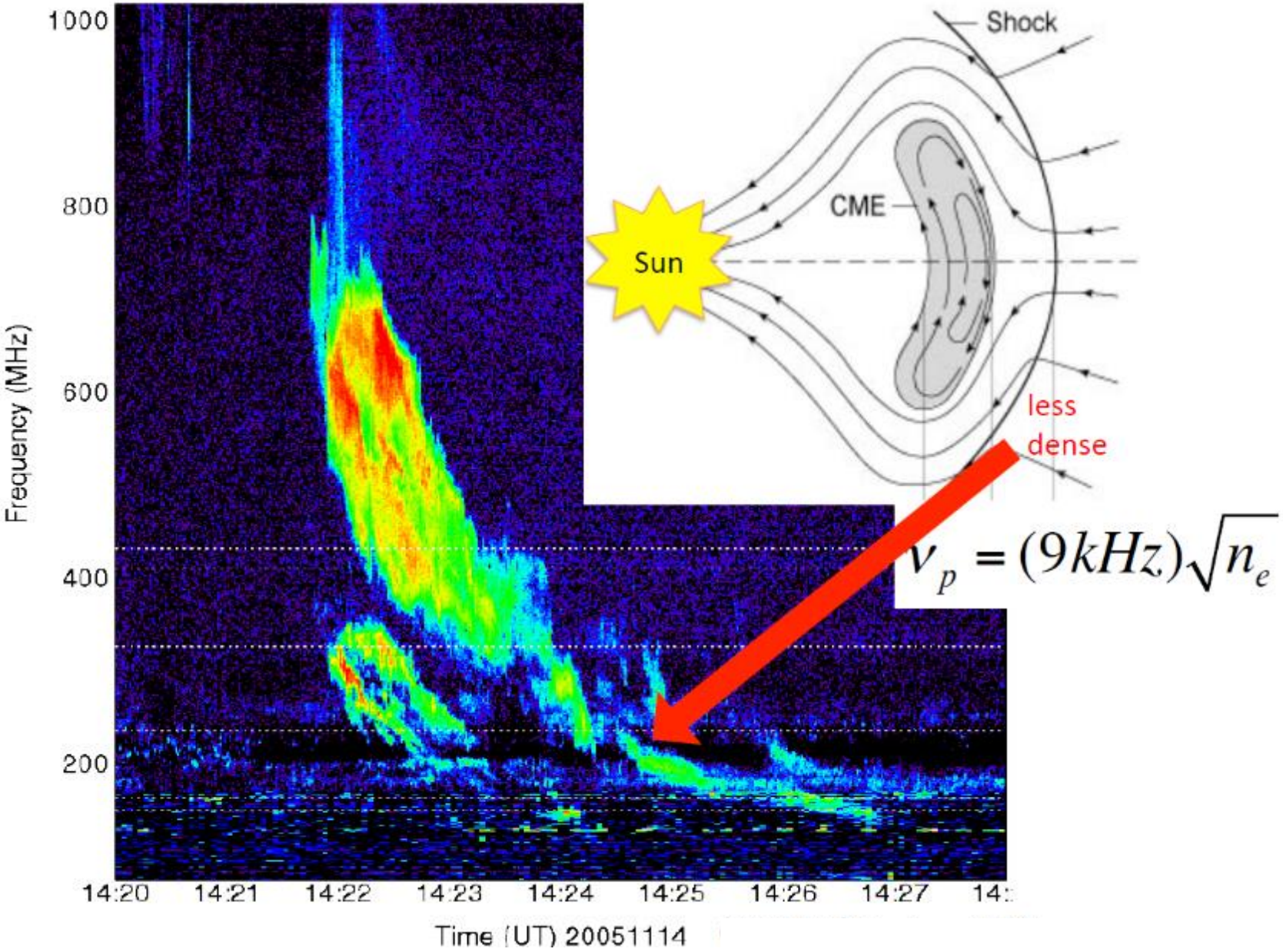


First detected by OSO-7 and Skylab in the early 1970s

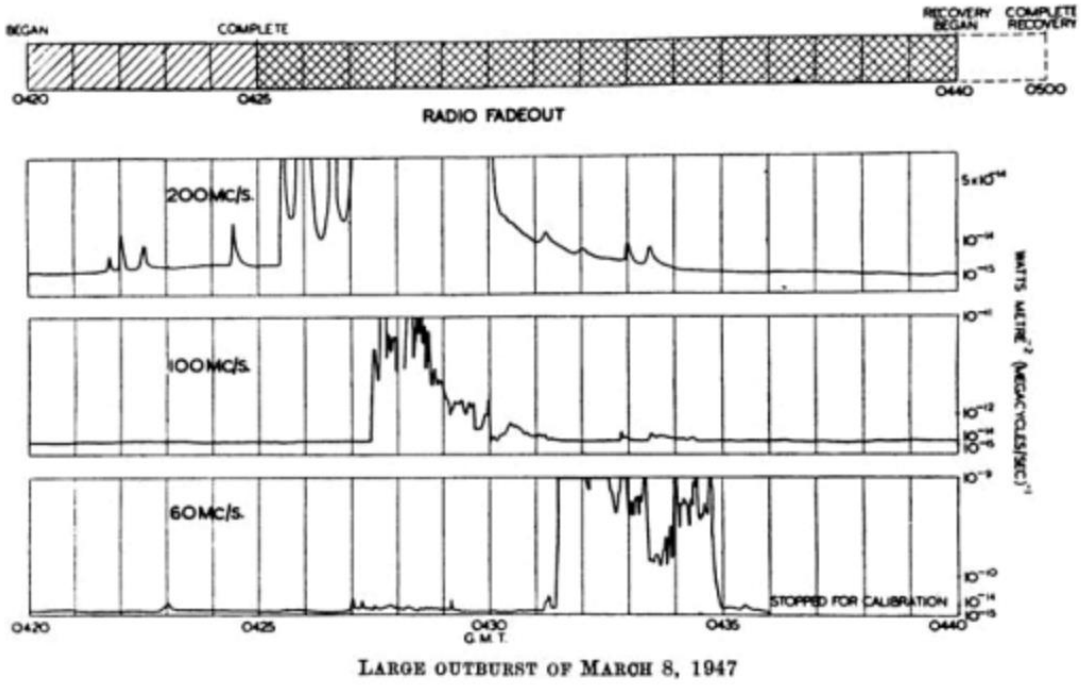
Type II radio bursts



Type II radio bursts



Brightest Bursts from the Sun



LARGE OUTBURST OF MARCH 8, 1947

Payne-Scott et al. Nature, 160 (1947), 256

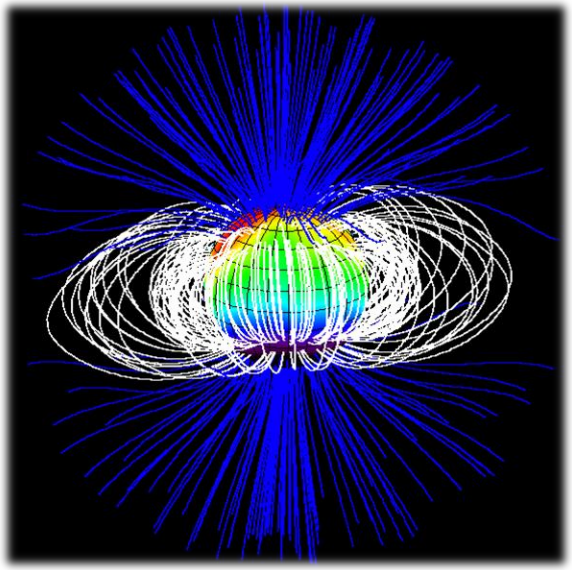
Giant Type II burst detected in 1947

Would be detectable out to tens of pc!

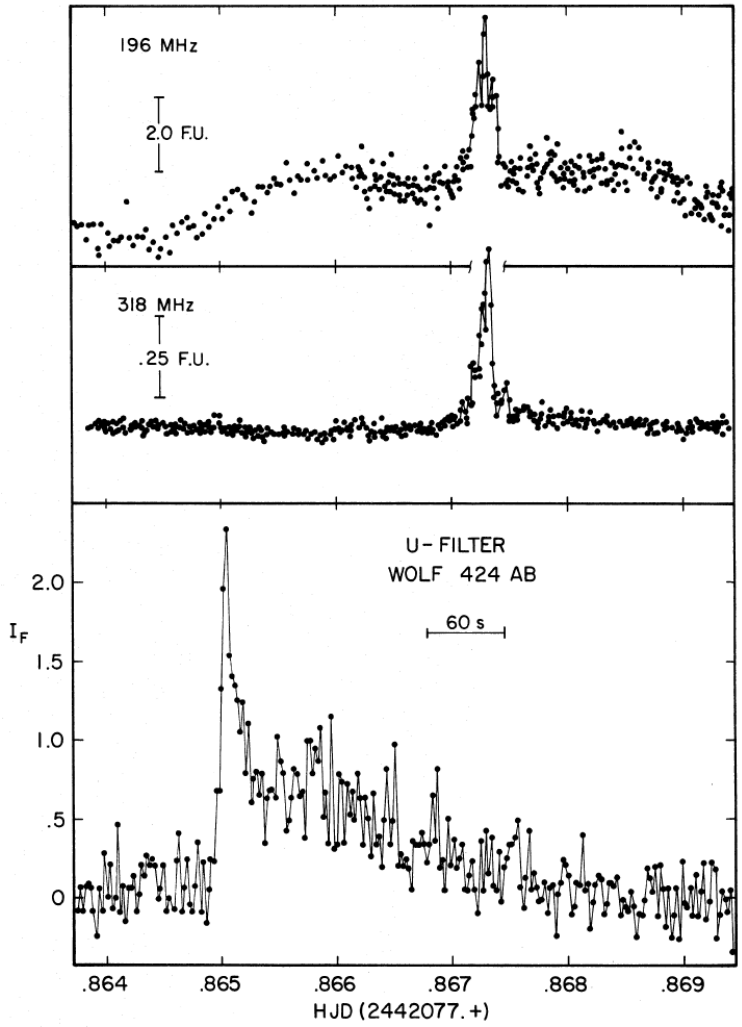
Rare events – mostly below 150 MHz

M dwarf radio bursts

- Strong evidence that M dwarfs produce very bright radio bursts
- Signatures of CMEs?
- Need broadband monitoring at low frequencies



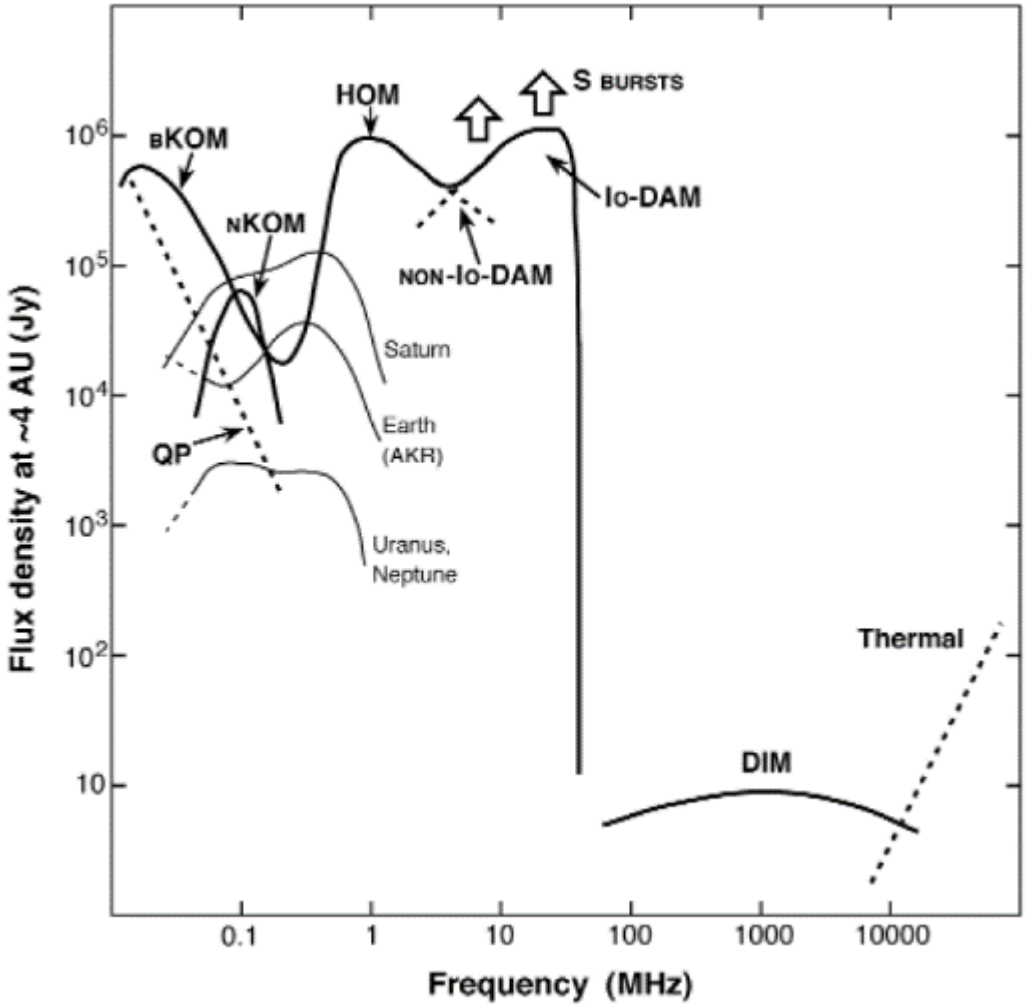
Donati et al. Science (2006)



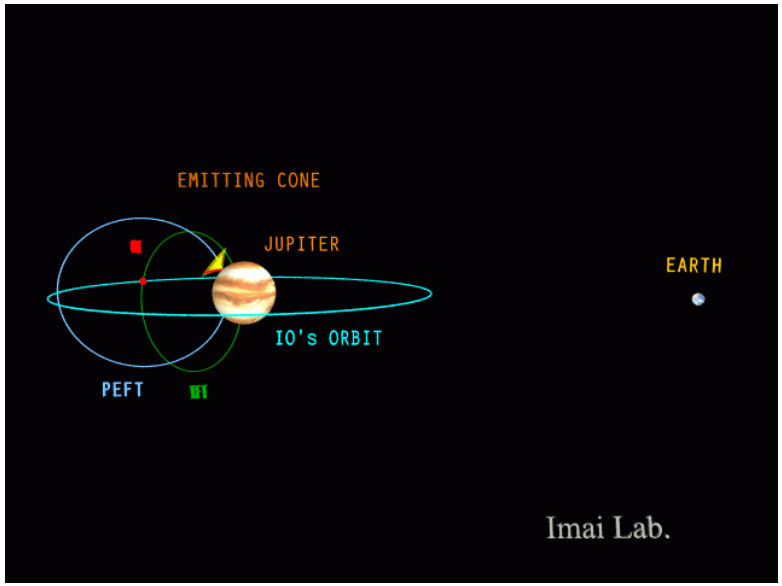
Spangler & Moffett et al. (1976)

Radio Emission from Solar System Planets

- *Voyagers*: Opens up field
- All gas giants and Earth have strong auroral radio emission



Zarka (1998)



$$B_{Gauss} = \nu_{MHz} / 2.8$$

Can we detect similar emissions from extrasolar planets?

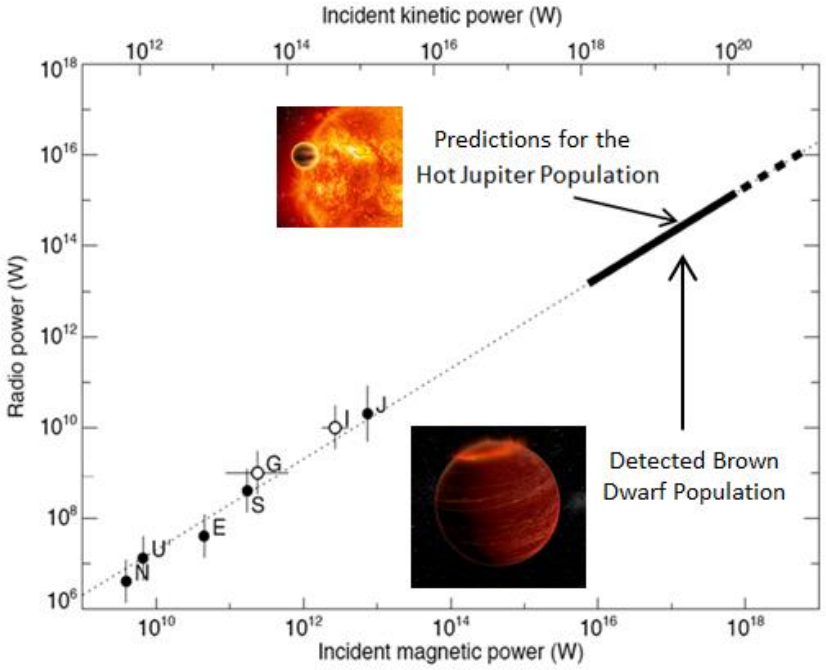
- Measure magnetic fields of exoplanets

- Allows measurement of rotation rate

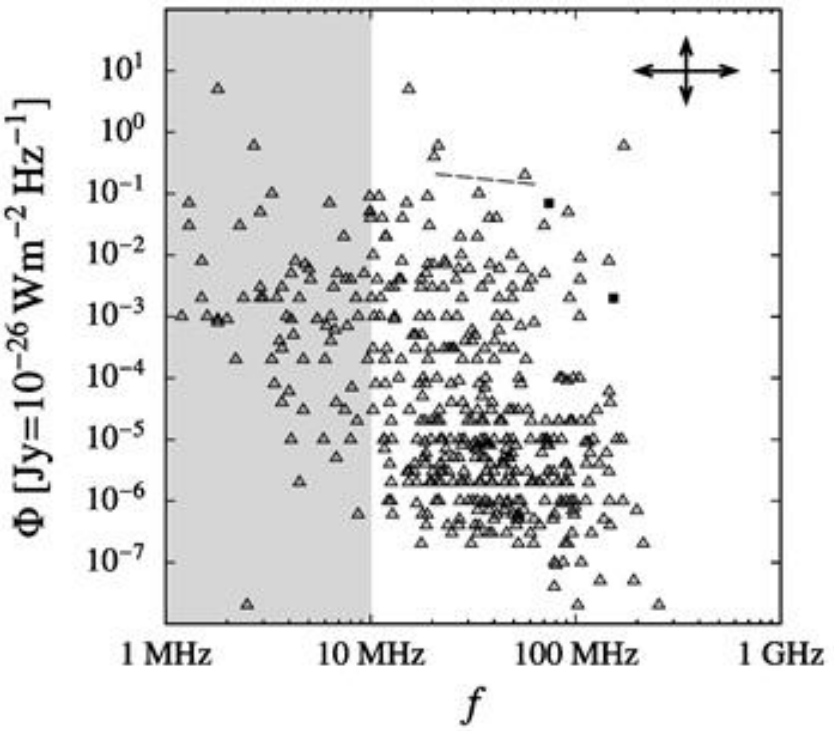
- Provides insight into internal structure of planet

Future detection method for exoplanets?

Can we Detect Exoplanets?

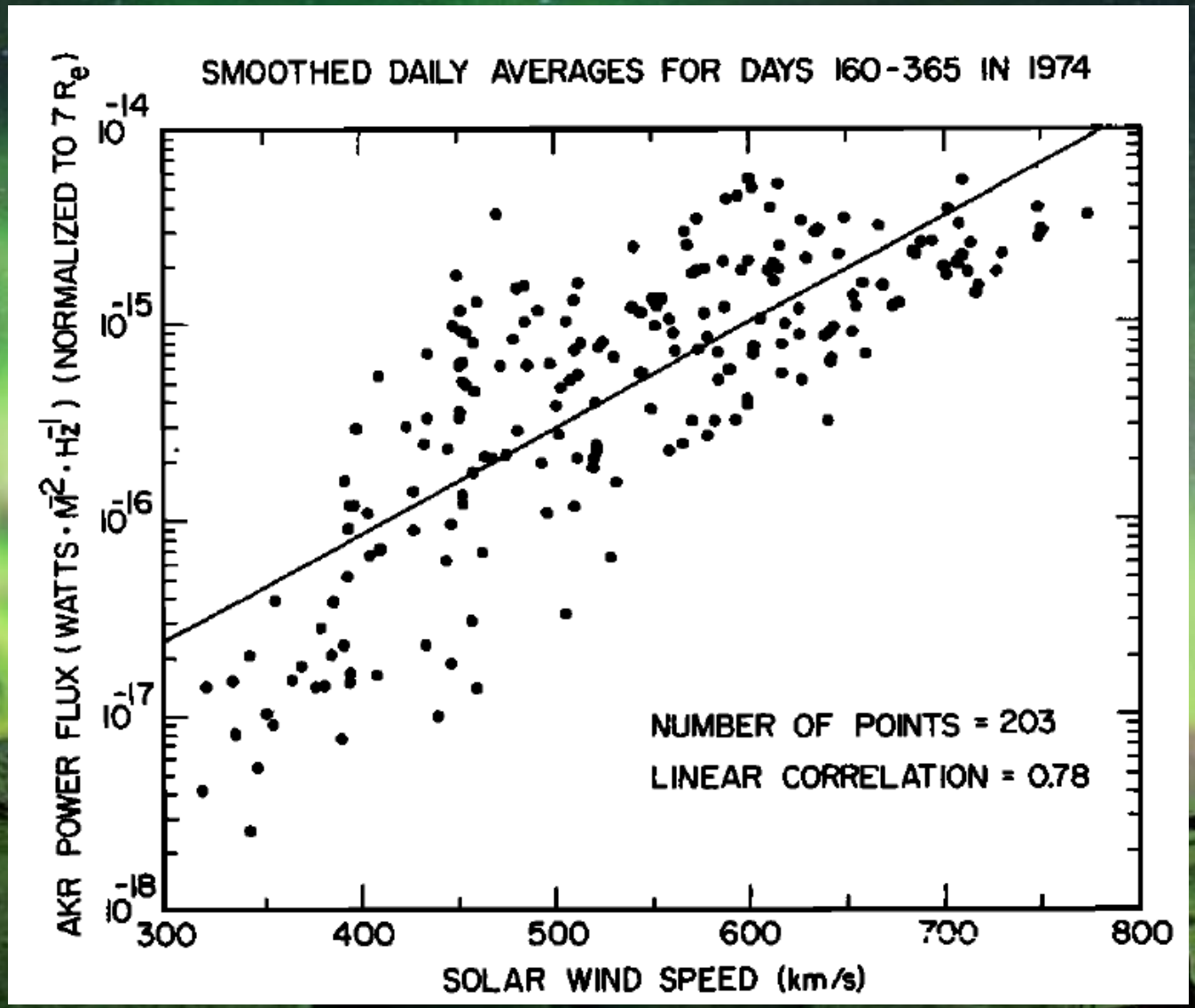


Adapted from Zarka (2007)



Greissmeier et al. (2007)

Searches have been ongoing for > 30 years – no detections



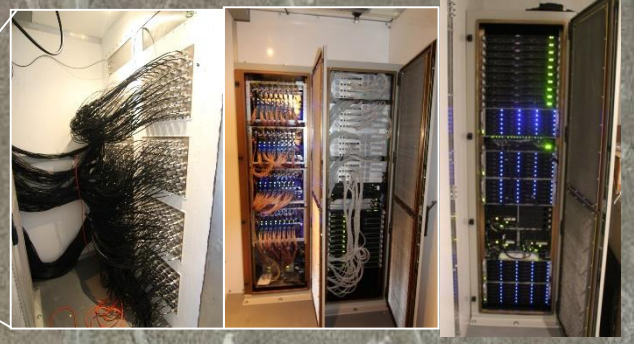
Gallagher & D'Angelo 1981

Stage 1: 2013-2014

Custom built array for all-sky imaging

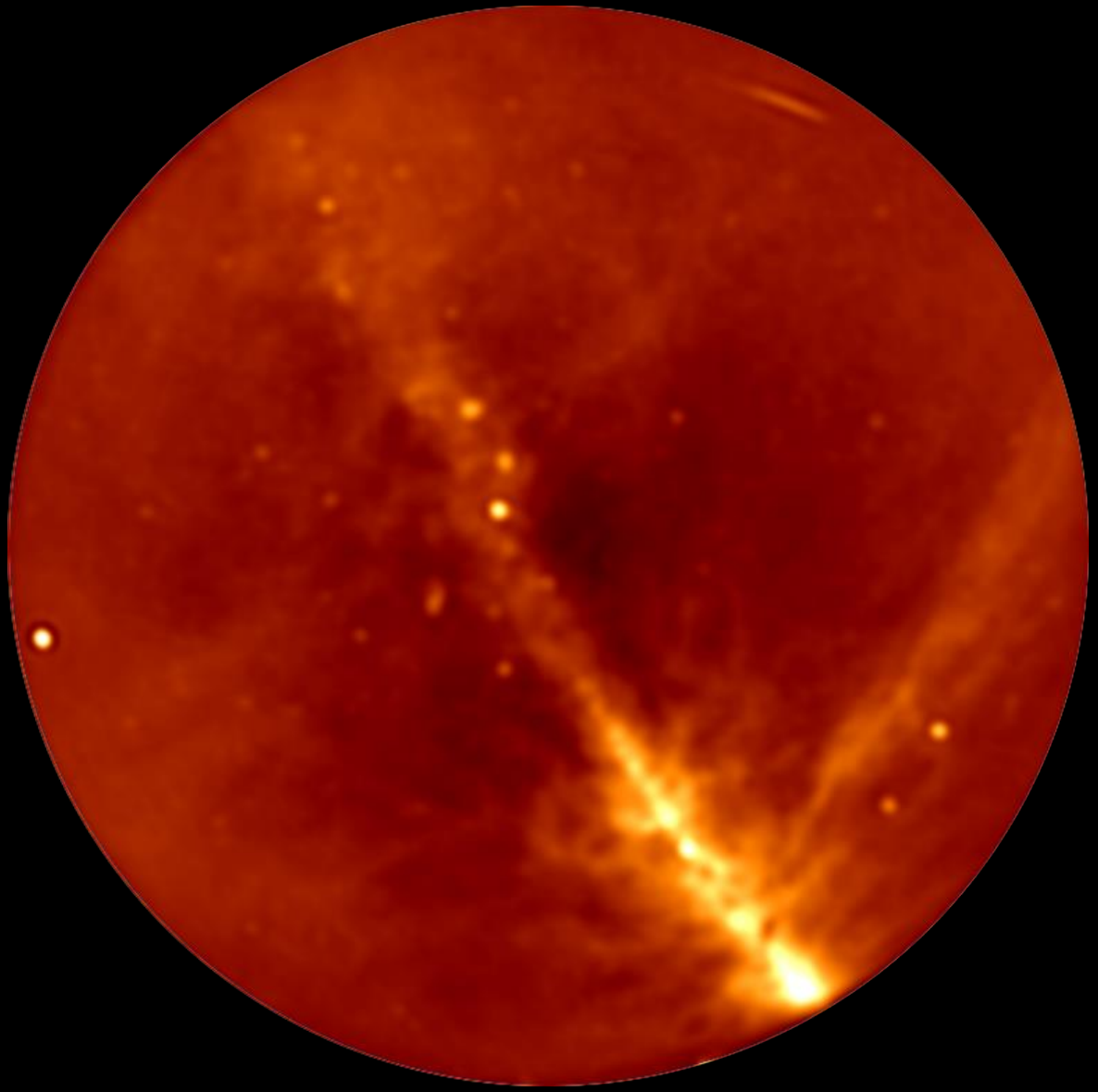
256 antennas
88 km of buried coaxial cable
1 km of fencing

200m



Two powerful back-ends:
1) LEDA correlator
2) All-sky Transient Monitor

Core Image (200m baselines)



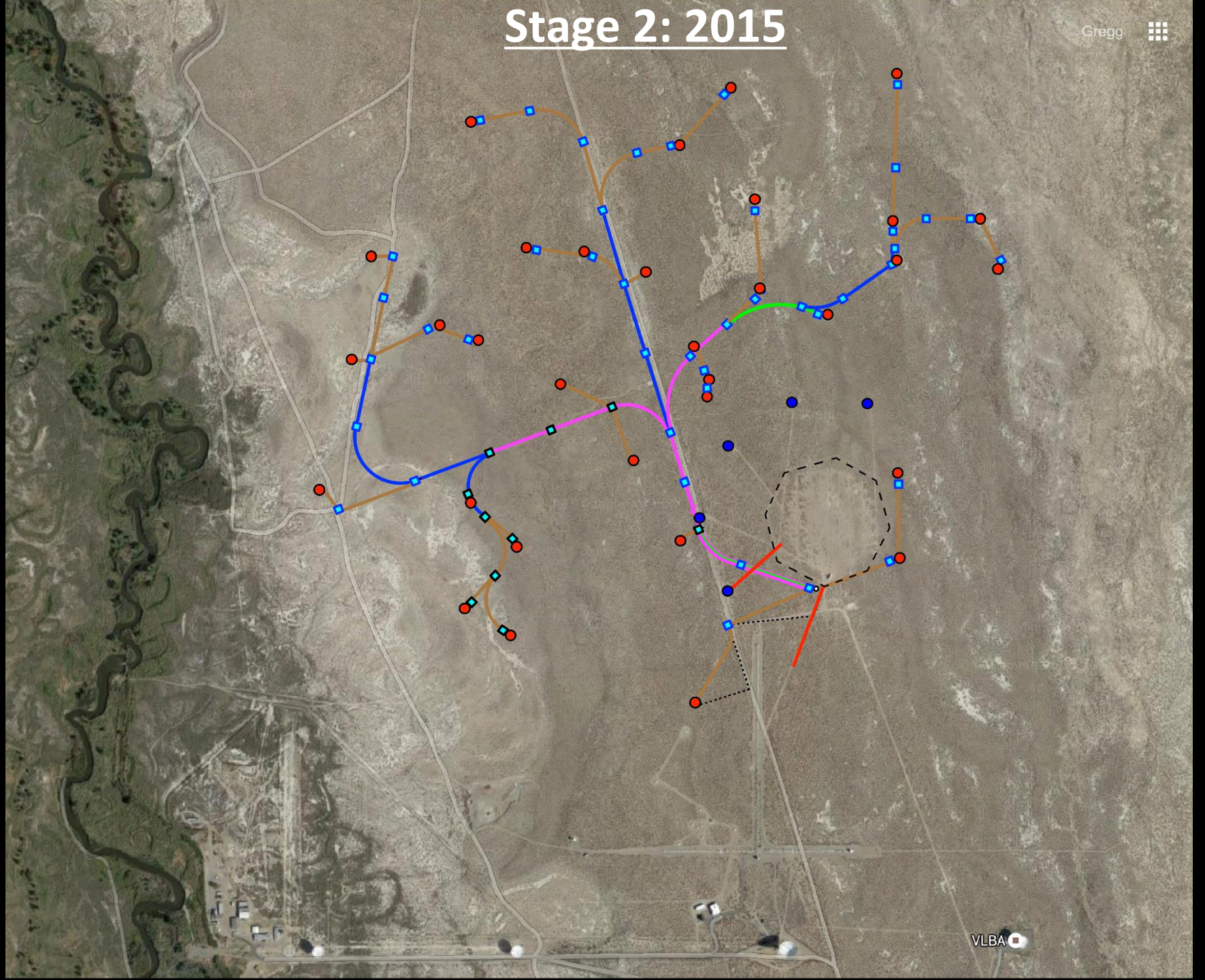
- 30 second snapshot with ~40 MHz bandwidth

- Confusion limit is ~few Jy

- Thermal noise is ~ 200 mJy

- Reach confusion noise in <0.1 seconds!

Stage 2: 2015

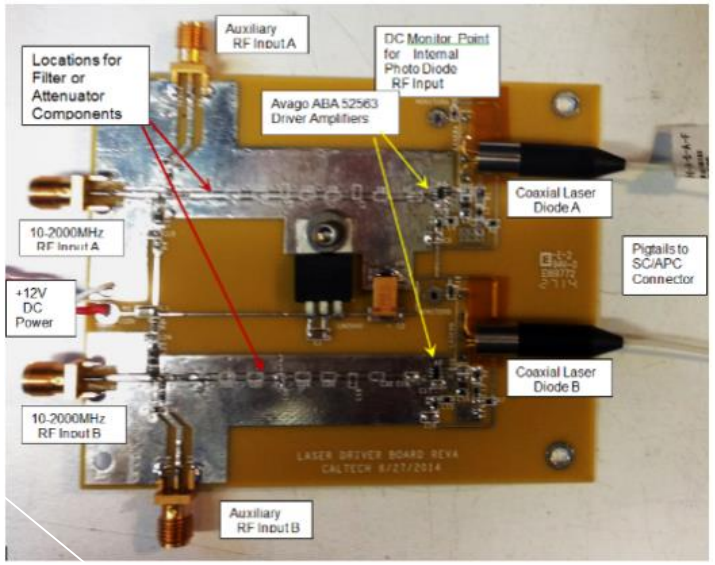


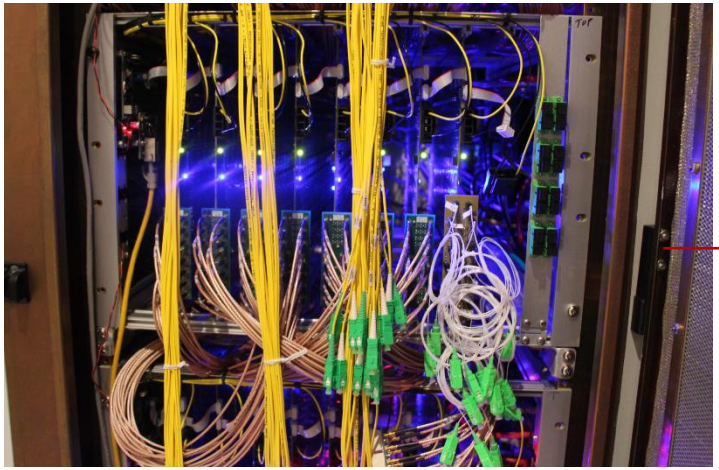
Longer baselines – 2015

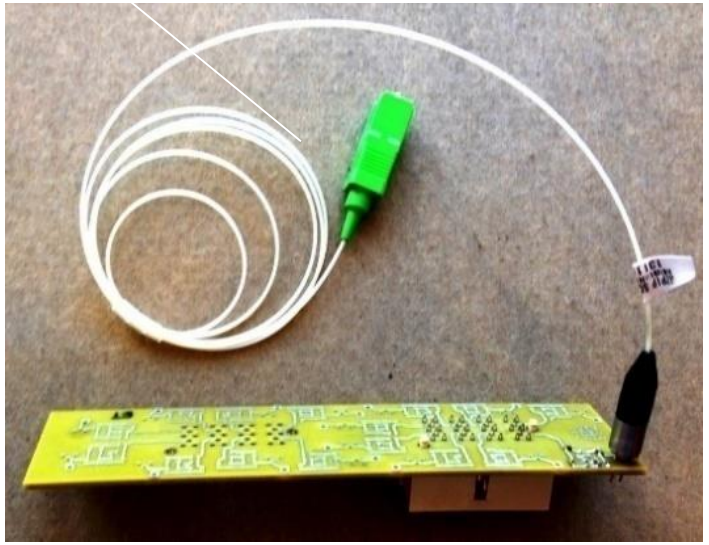
- **Large network of conduit holding 43 km of optical fiber**

- **6 fibers at each “station”**

Longer baselines – 2015



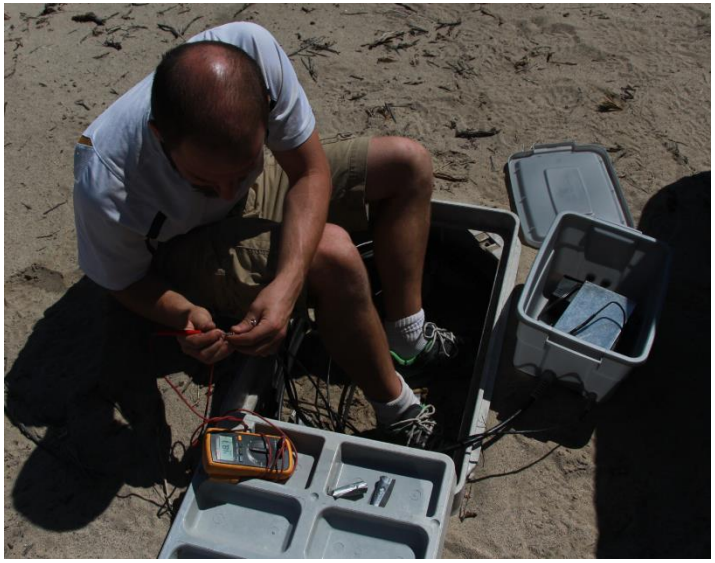


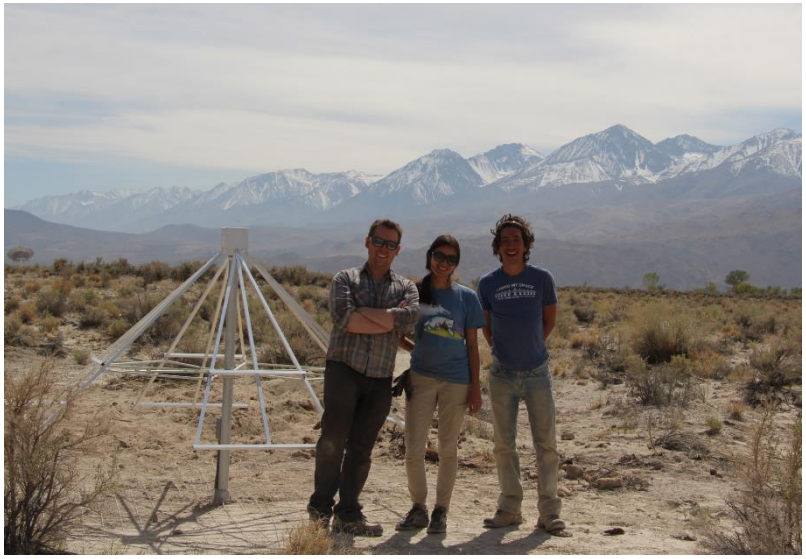


Custom fiber links designed by Sandy Weinreb and his group

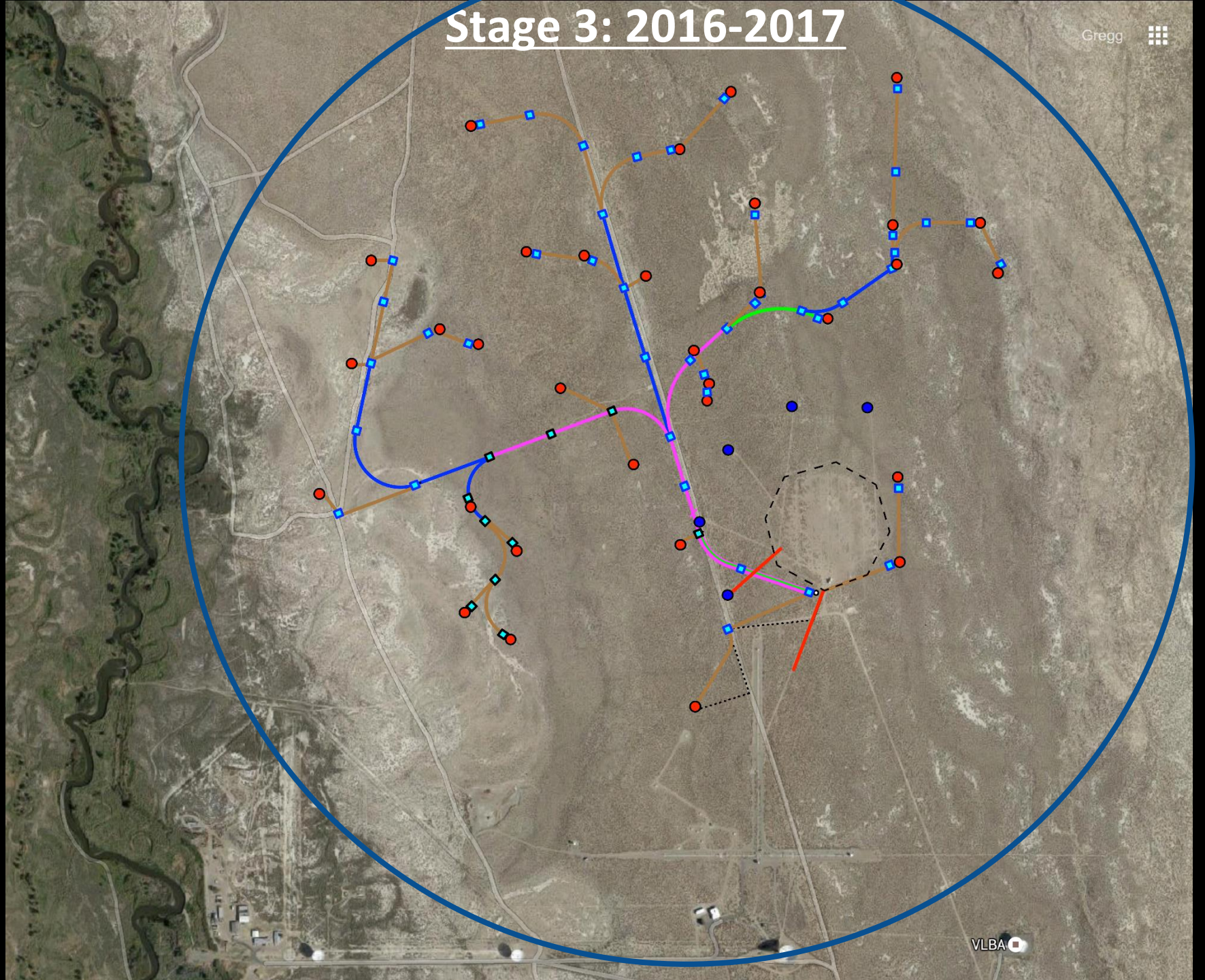
– cost per antenna now <$100 (vs $2000 for commercial hardware)

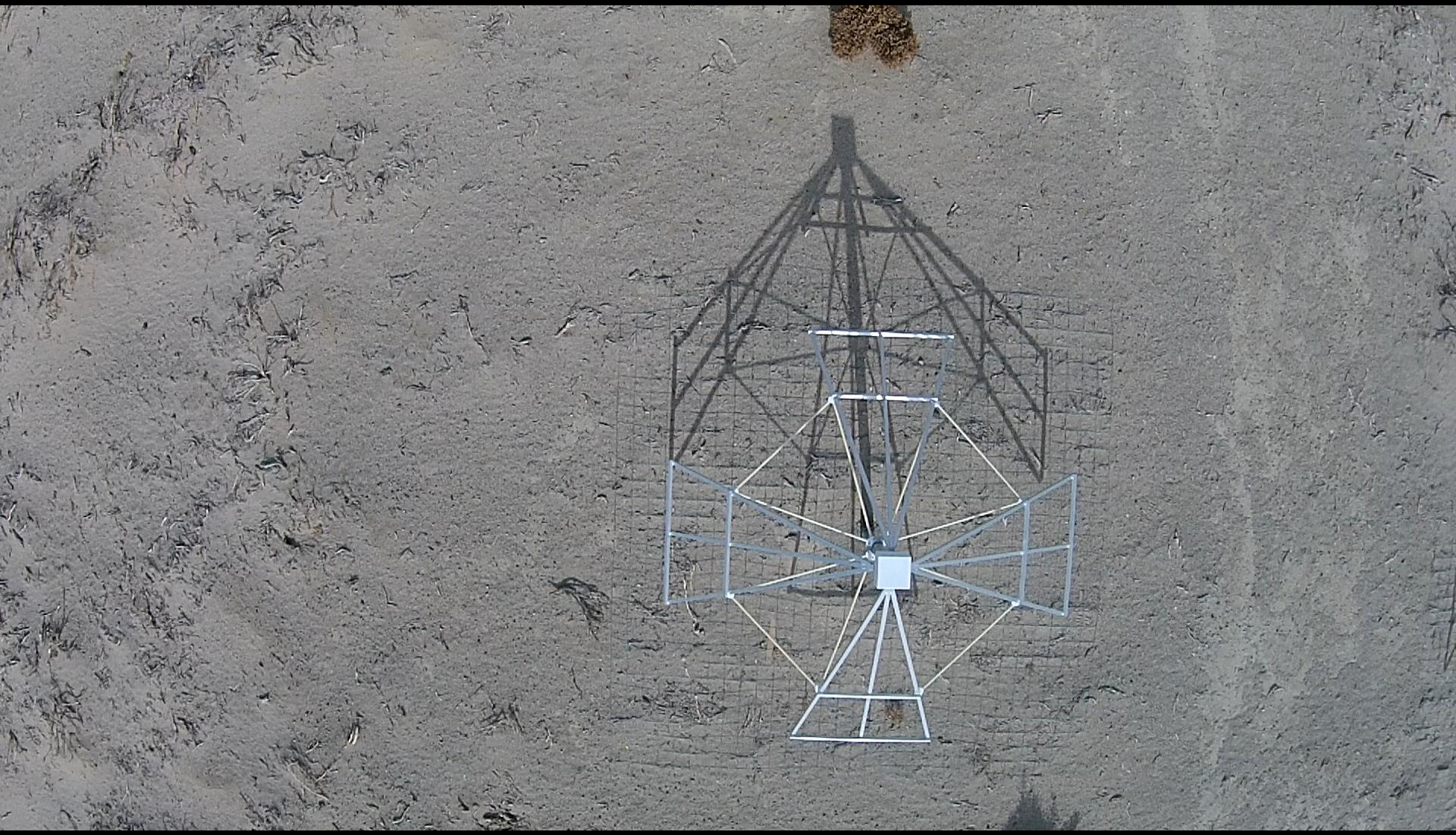
Longer baselines – 2015

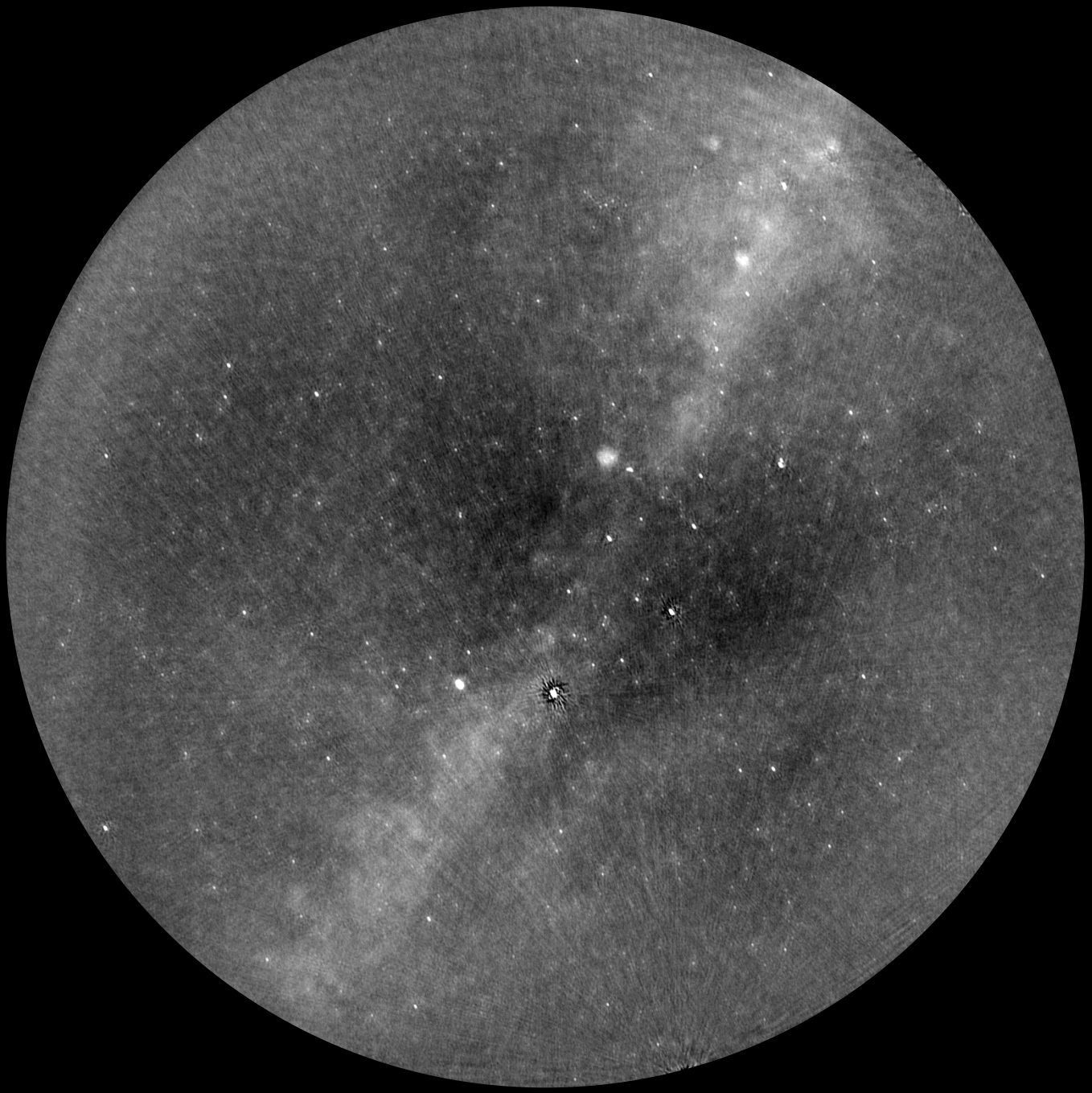




Stage 3: 2016-2017



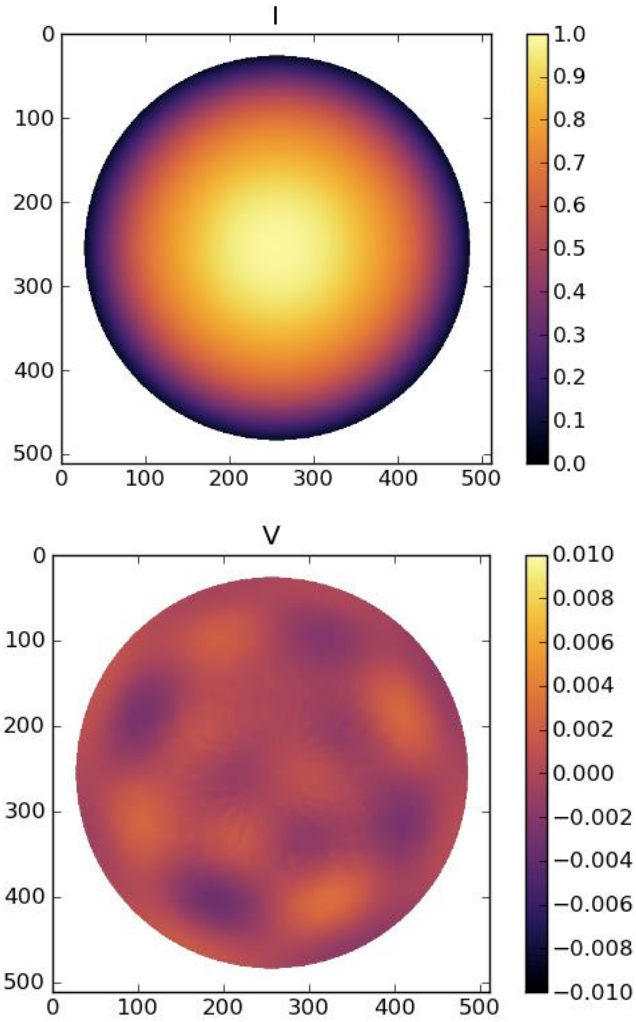


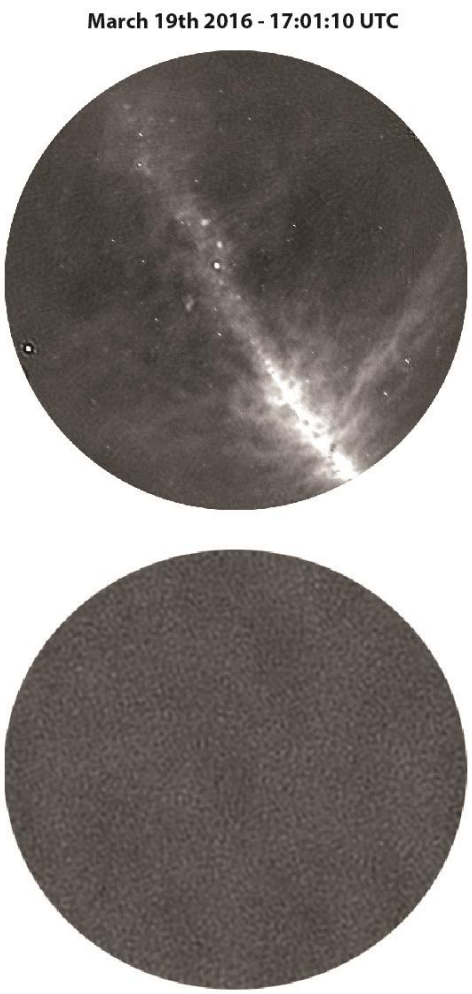


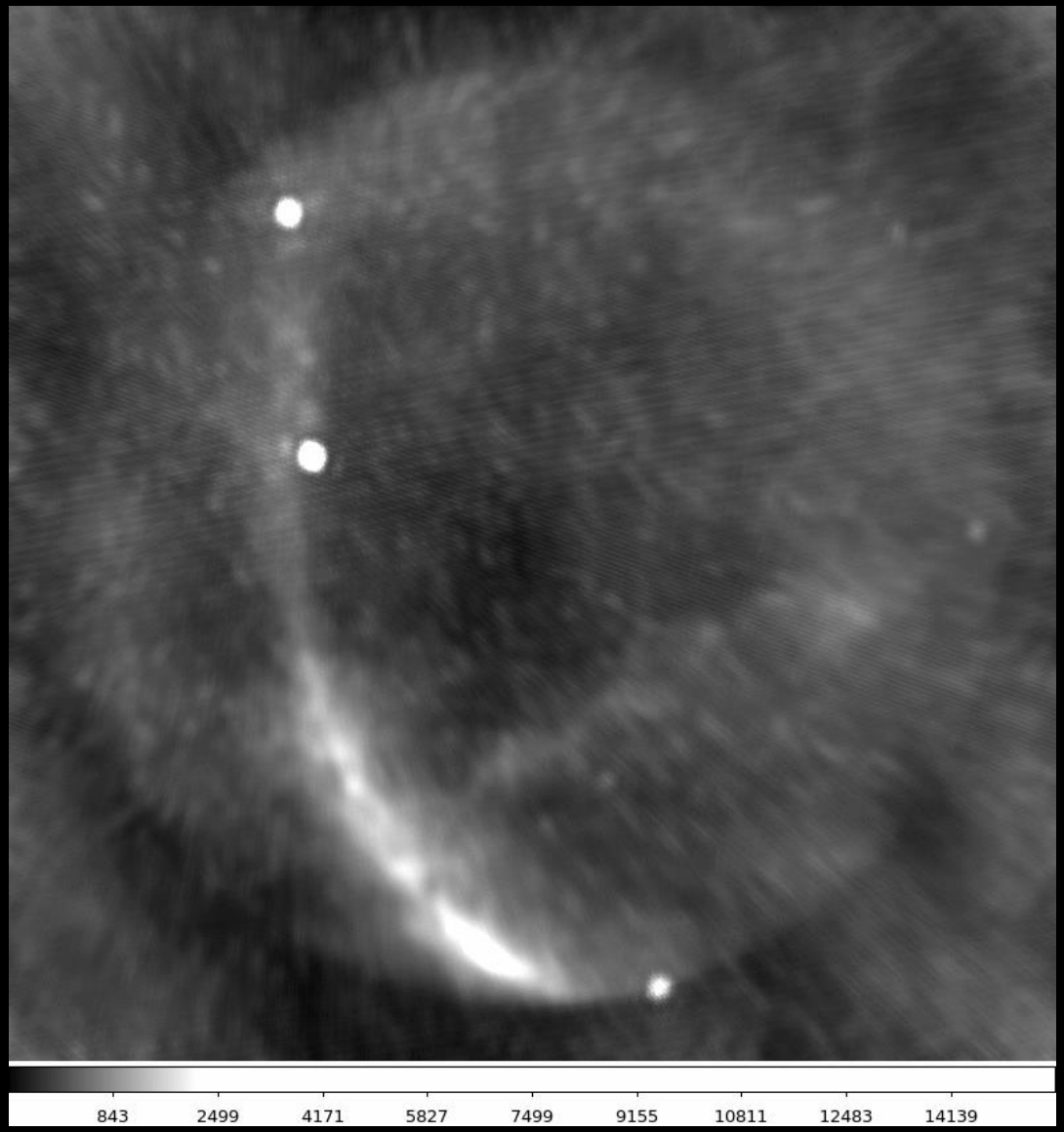

30 degrees

Marin Anderson et al. 2016 – in prep.

PRELIMINARY

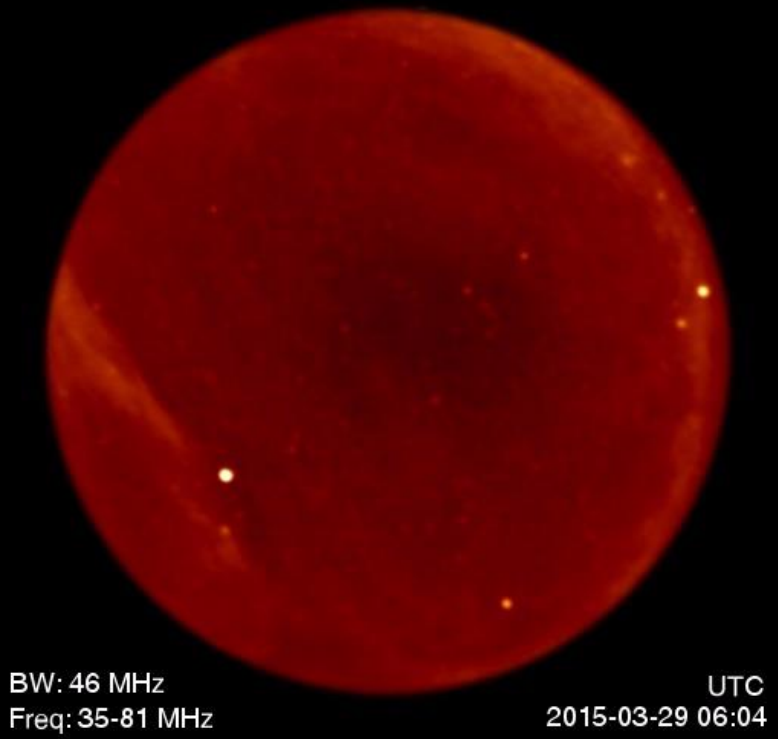




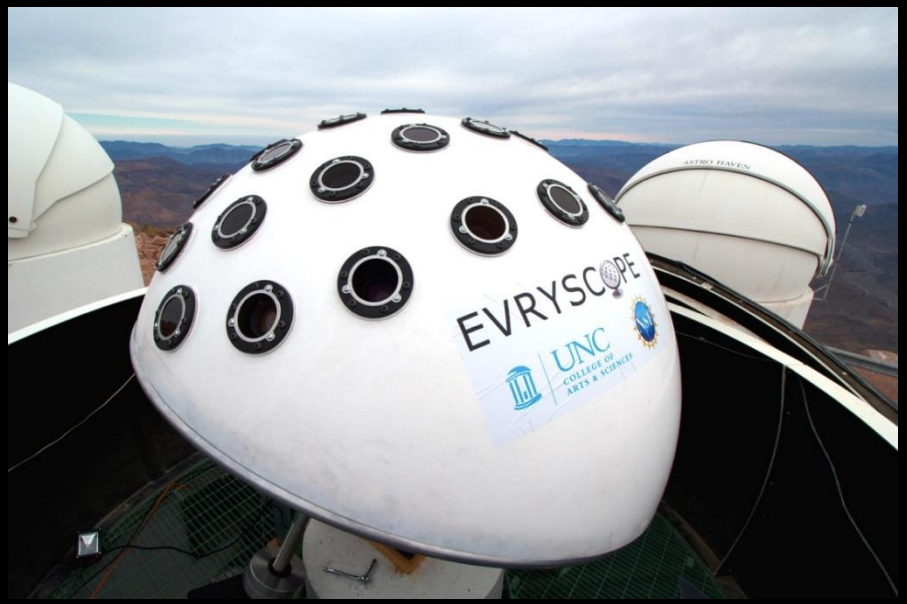


Work of Ryan Monroe

Extrasolar Space Weather Monitoring!



OVRO-LWA: 352 antennas



Evryscope: 24 x 61 mm-aperture telescopes

Nicholas Law and Robert Quimby

Both telescopes will continuously monitor 3000 stars out to 25 pc

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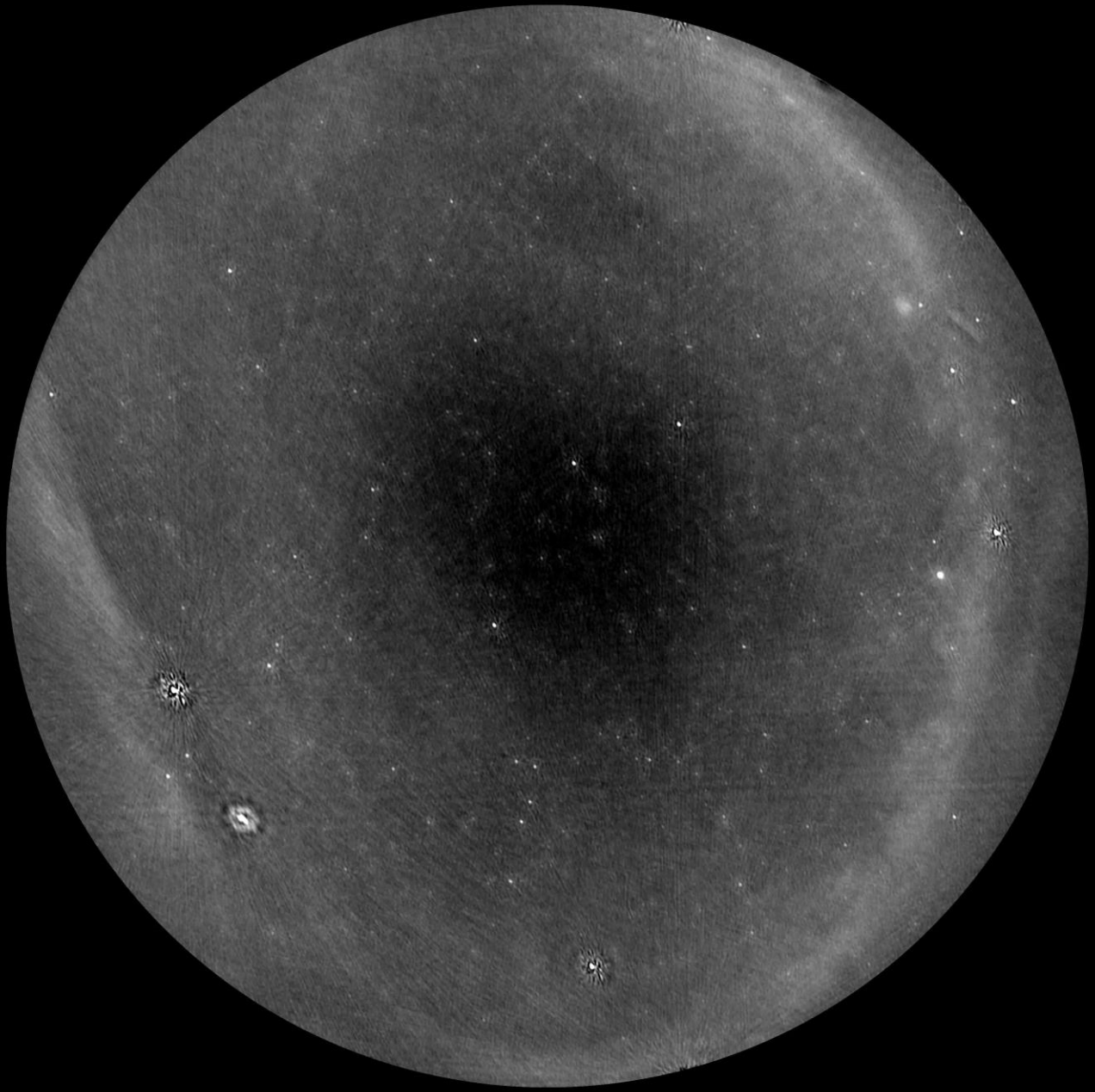
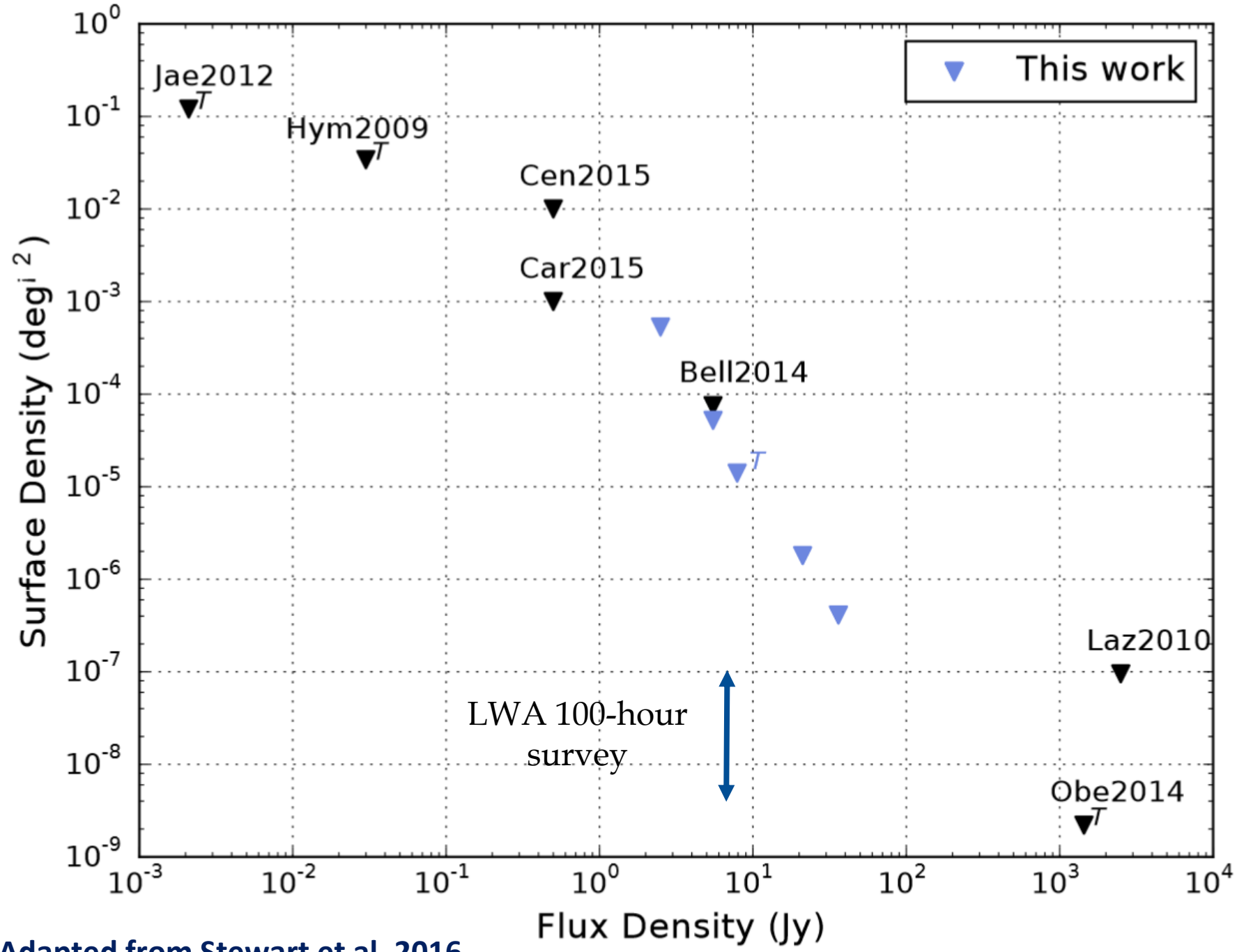


Solar Coronal Mass Ejection



Adapted from Stewart et al. 2016

Summary

OVRO-LWA Stage 2 construction complete

Stage 3 construction proposed via NSF ATI

100 hour survey complete – early science coming soon

Continuous (buffered) observing planned for LIGO-VIRGO O2 run

1000 hour survey in late 2016

Continuous operation in 2017