

# Strategic uses of single dishes (and GB) in Fast Radio Burst detection

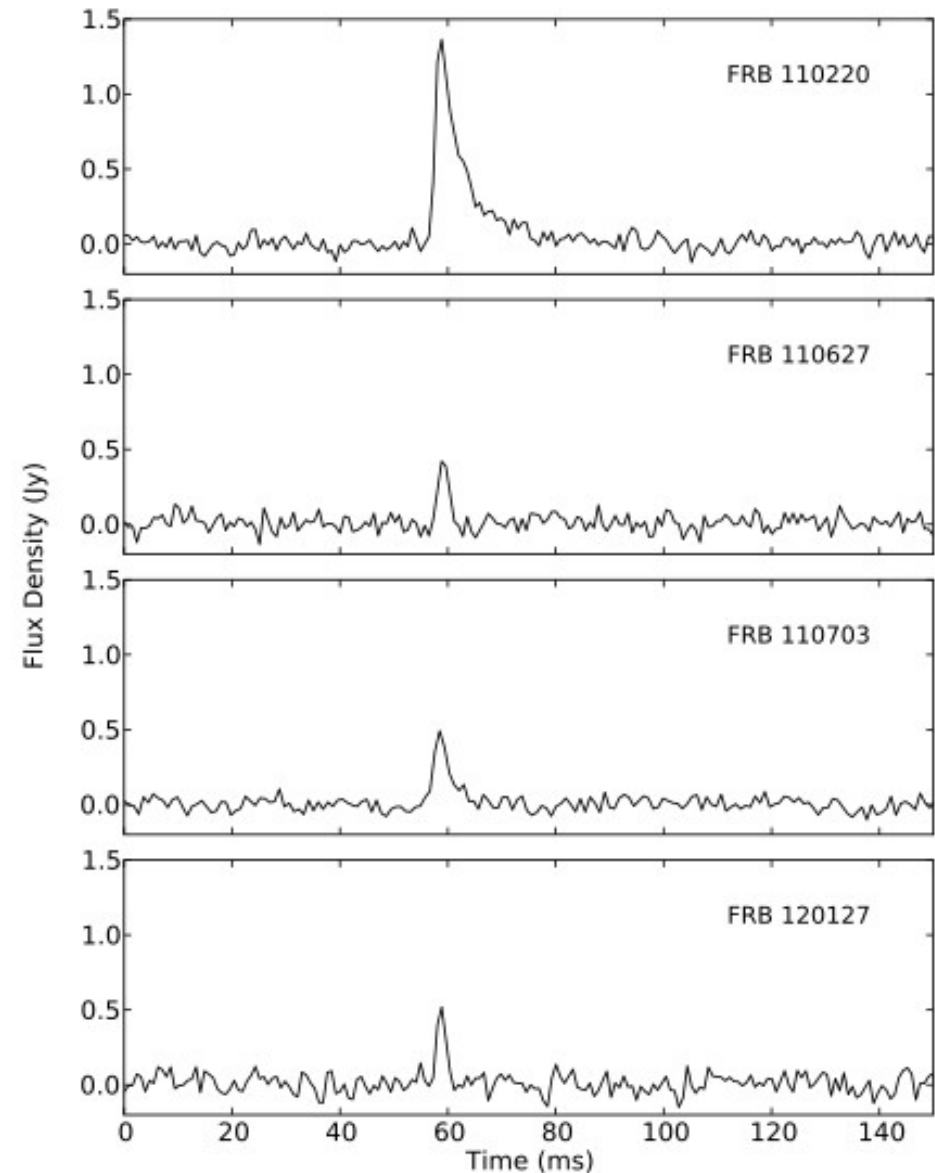
Duncan Lorimer, Dept. of Physics and Astronomy, West Virginia University



Credit: Swinburne

# FRB lowdown

- 21 published so far
- Flux  $> 0.5$  Jy @ 1.4 GHz
- Pulse widths  $>$  few ms
- Highly dispersed
- Weakly scattered
- One FRB so far repeats!
- Few arcmin localization
- One counterpart so far
- ~few x 1000/day/sky

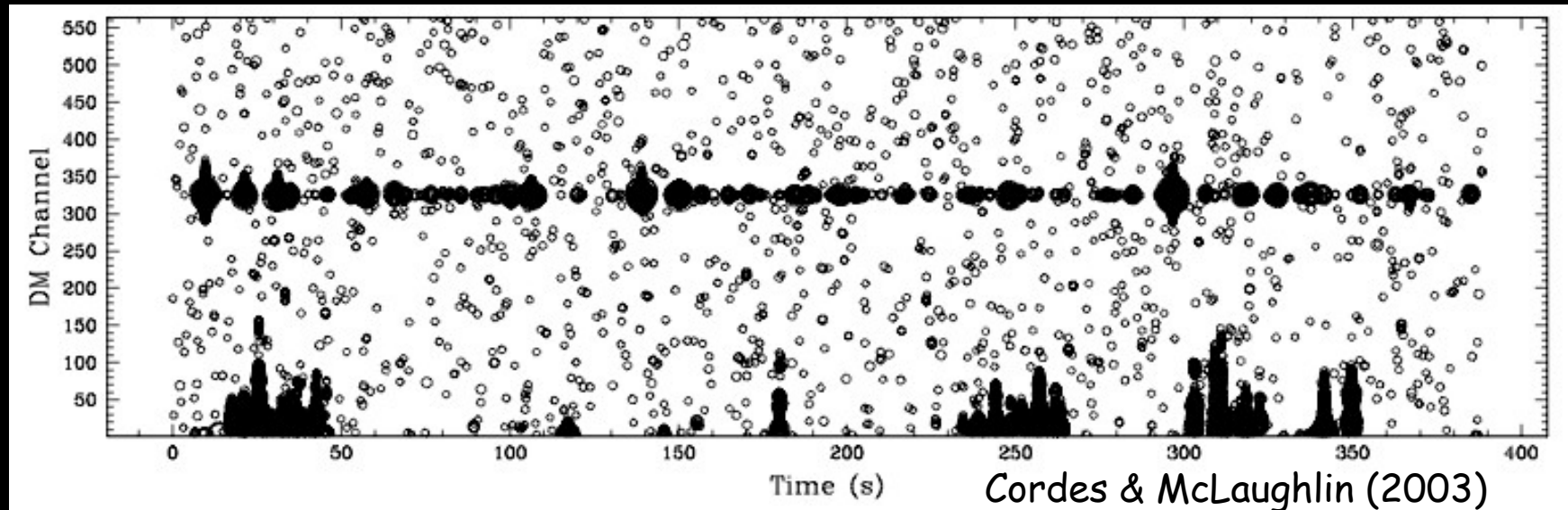
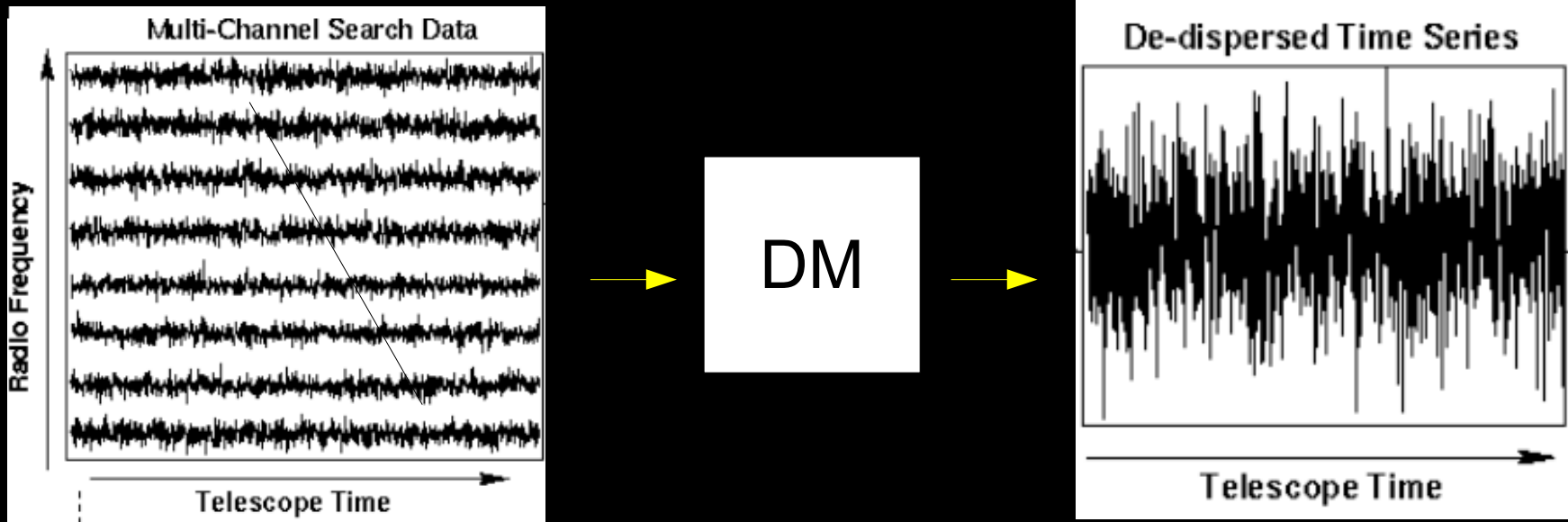


Credit: Thornton et al. (2013)

# What might FRBs probe?

- New/exciting physics
  - Cosmological NS census?
  - Non-stellar origin?
  - Fundamental tests?
- The intergalactic medium
  - Electron content  $\square$  missing baryons?
  - Magnetic field  $\parallel$  to line of sight
- Cosmology
  - Rulers
  - DM halos, DM/DE parameterization

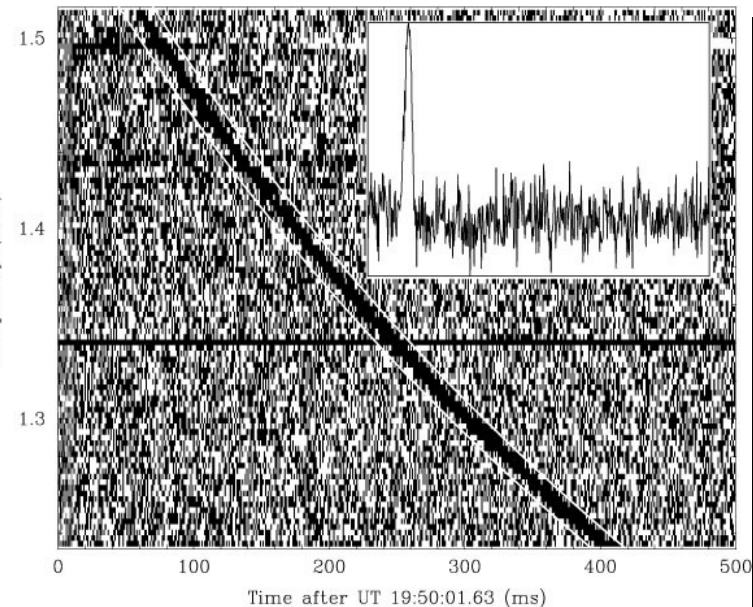
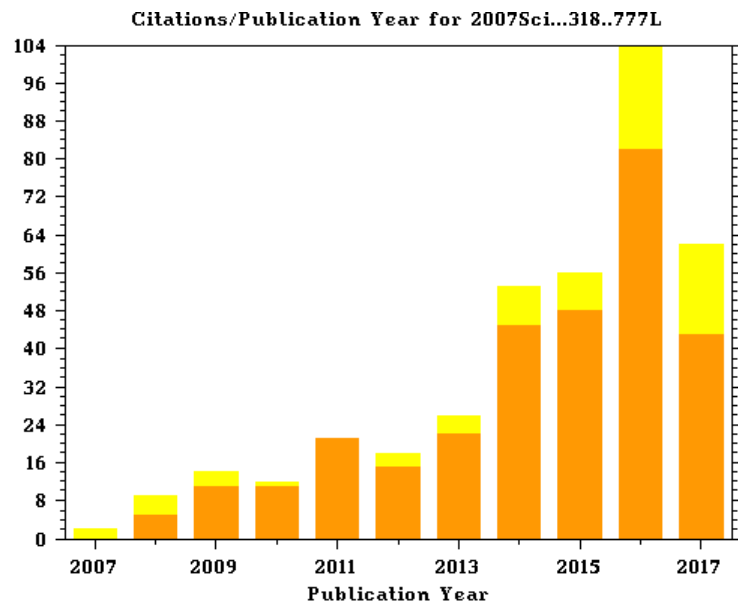
# Single-pulse search pipeline



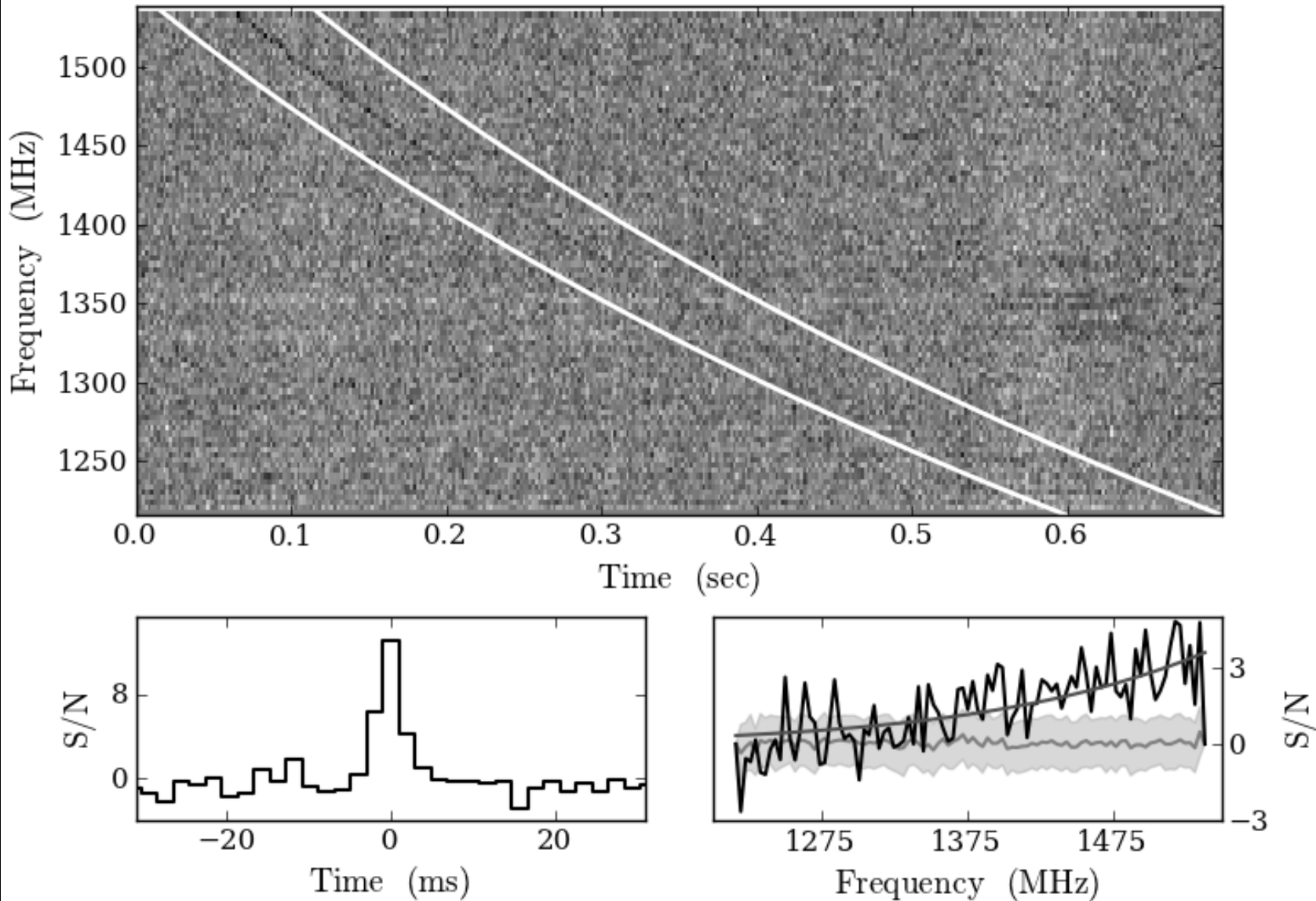
# A Bright Millisecond Radio Burst of Extragalactic Origin

D. R. Lorimer,<sup>1,2\*</sup> M. Bailes,<sup>3</sup> M. A. McLaughlin,<sup>1,2</sup> D. J. Narkevic,<sup>1</sup> F. Crawford<sup>4</sup>

Pulsar surveys offer a rare opportunity to monitor the radio sky for impulsive burst-like events with millisecond durations. We analyzed archival survey data and found a 30-jansky dispersed burst, less than 5 milliseconds in duration, located 3° from the Small Magellanic Cloud. The burst properties argue against a physical association with our Galaxy or the Small Magellanic Cloud. Current models for the free electron content in the universe imply that the burst is less than 1 gigaparsec distant. No further bursts were seen in 90 hours of additional observations, which implies that it was a singular event such as a supernova or coalescence of relativistic objects. Hundreds of similar events could occur every day and, if detected, could serve as cosmological probes.



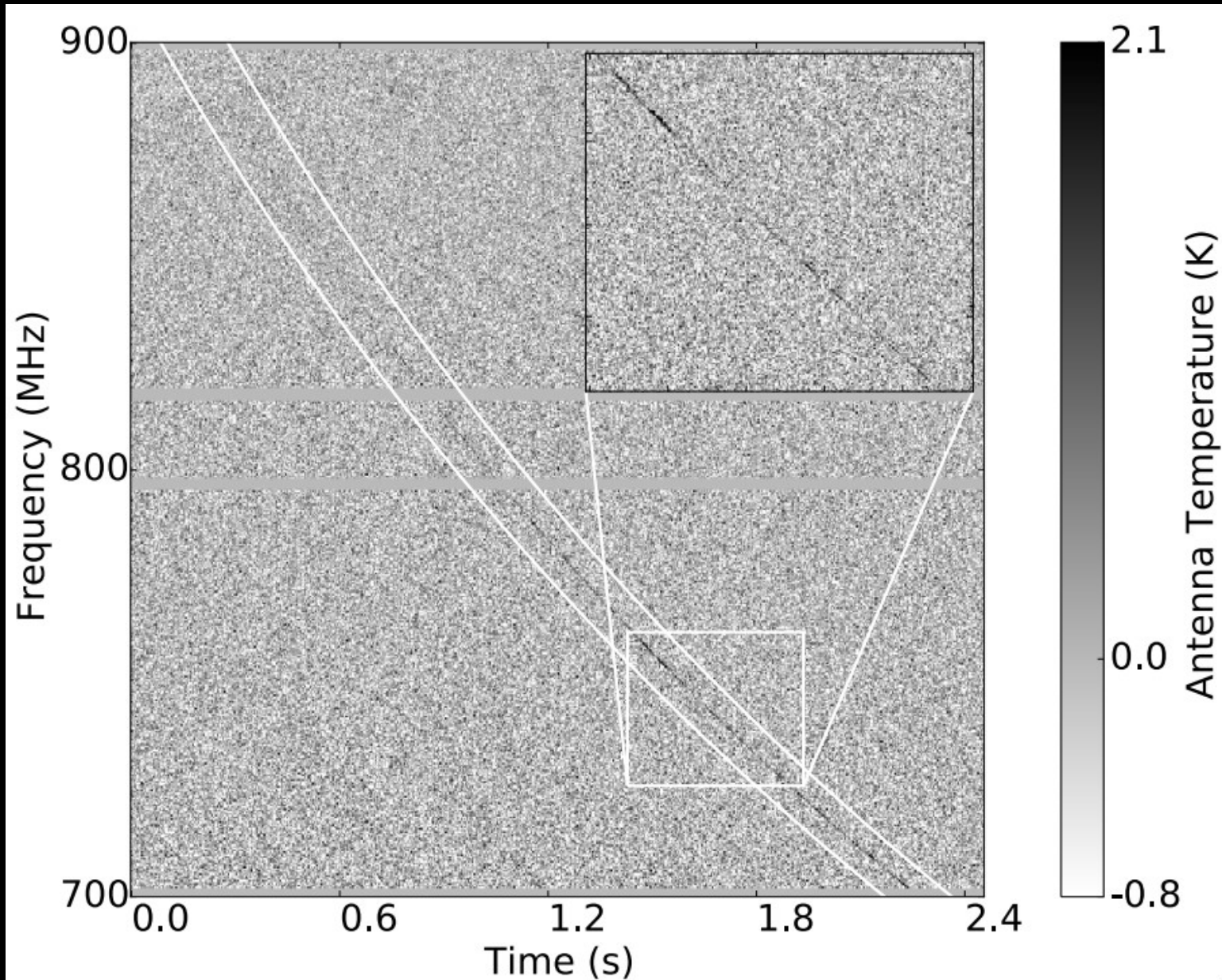
# 2014: FRB 121102 at Arecibo



Credit: Spitler et al. (2014)



# 2015: FRB 110523 at GBT



Credit: Masui et al. (2015)

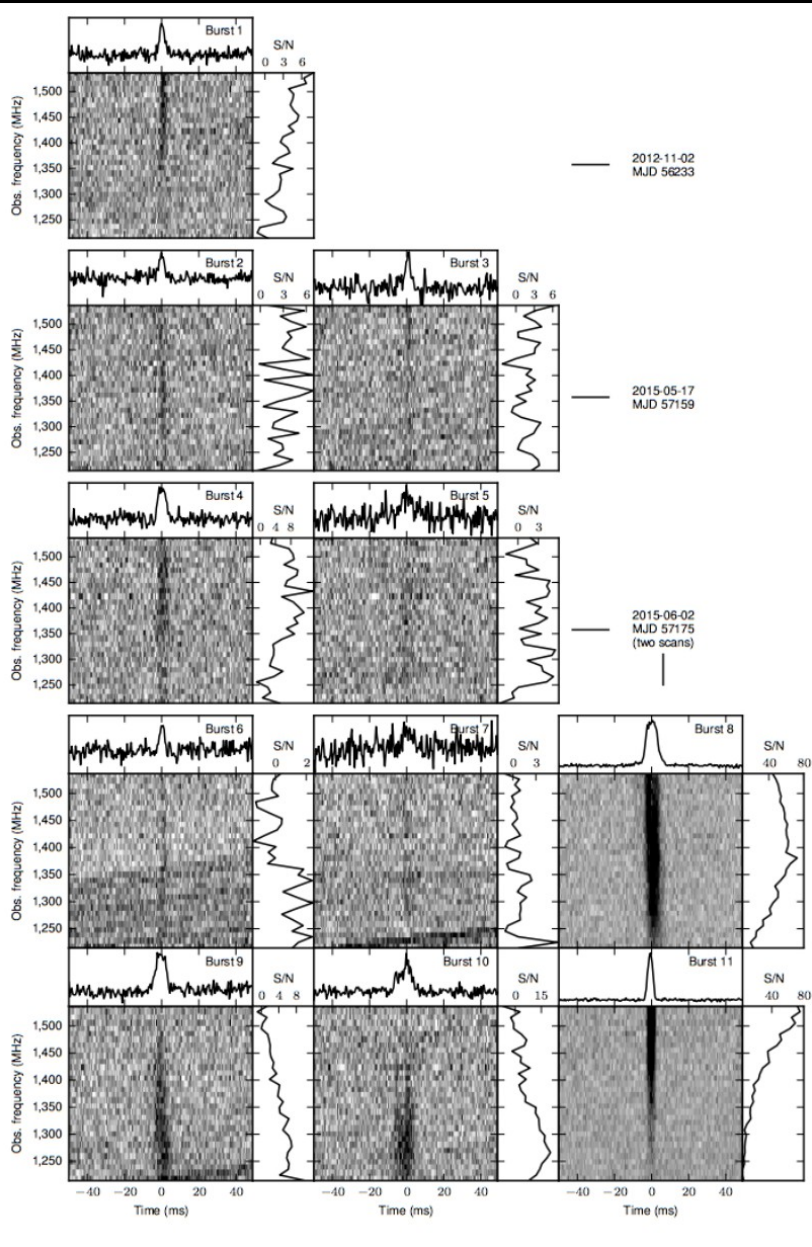
# More “theories” than bursts!

- Colliding compact objects (e.g. NS-NS)
- Supernovae
- Collapsing NS  $\square$  BH (blitzar)
- Black hole absorbing NSs
- Giant pulses from pulsars/magnetars
- Neutron star - asteroid belt interaction
- More exotic (strange) star interactions
- Galactic Flare Stars
- Light sails from ET
- Dark matter
- Cosmic strings
- White holes



# 2016: FRB 121102 repeats!

Credit: Spitler et al. and Scholz et al. (2016)



□ No!



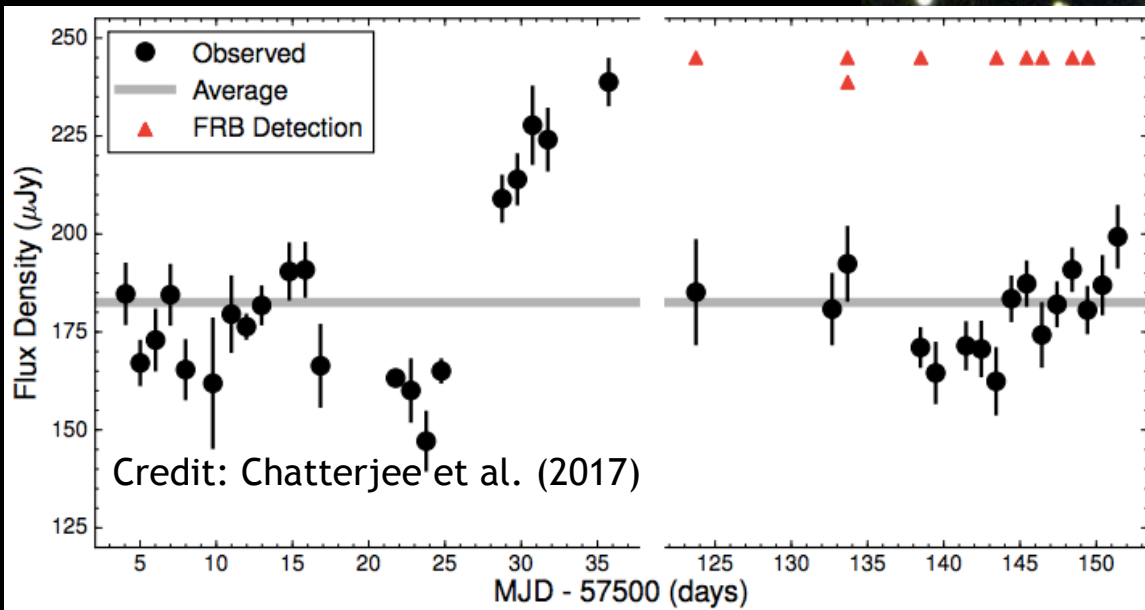
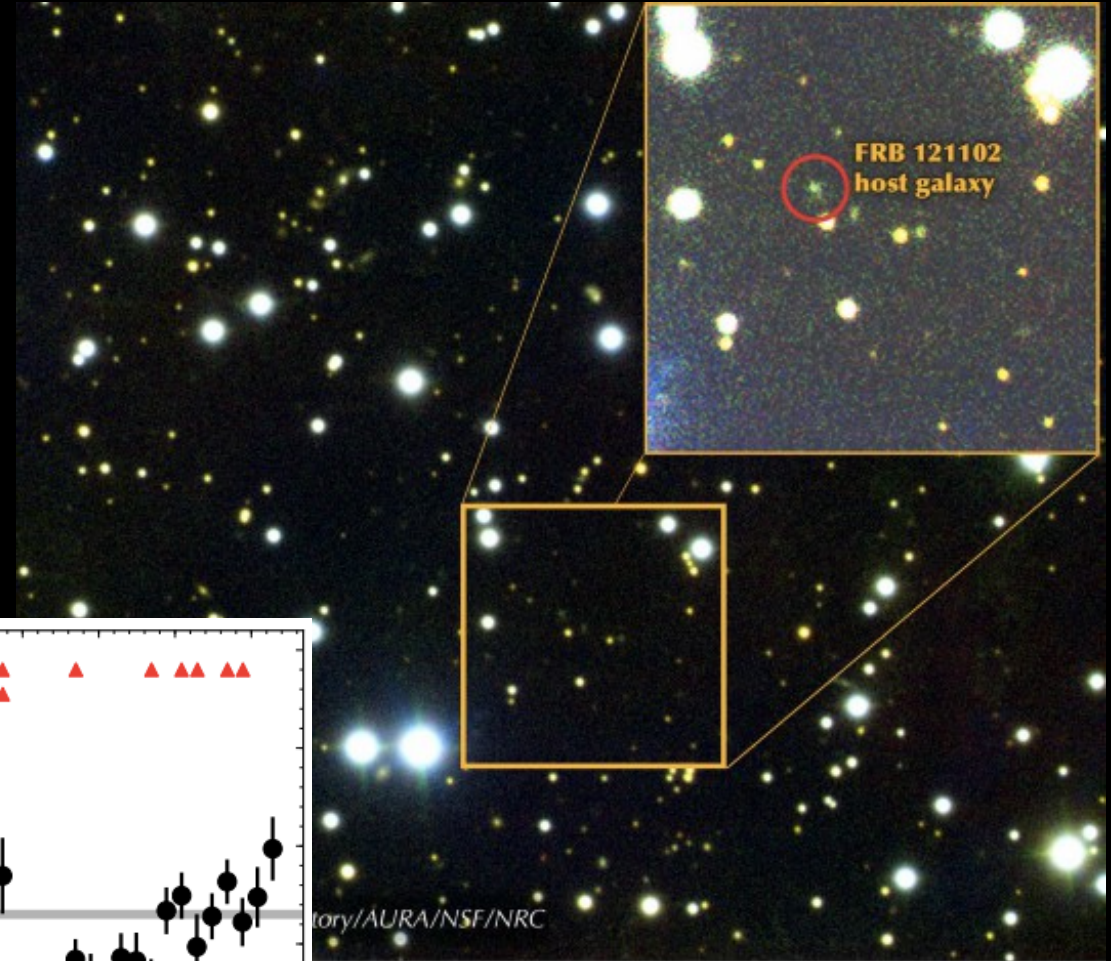
□ No!



□ Maybe?

... or maybe something else?

# 2017: FRB 121102 localized!



$z = 0.19$   
(2.3 billion yr)

# We have no idea what FRBs are!

- What is the source of FRB 121102?
  - Are the radio sources related?
  - Magnetar/AGN interaction?
- Is FRB 121102 representative?
  - Do all FRBs repeat?
  - Are there multiple classes?
- What are best strategies going forward?
  - Positional localization crucial
  - Large area coverage also needed



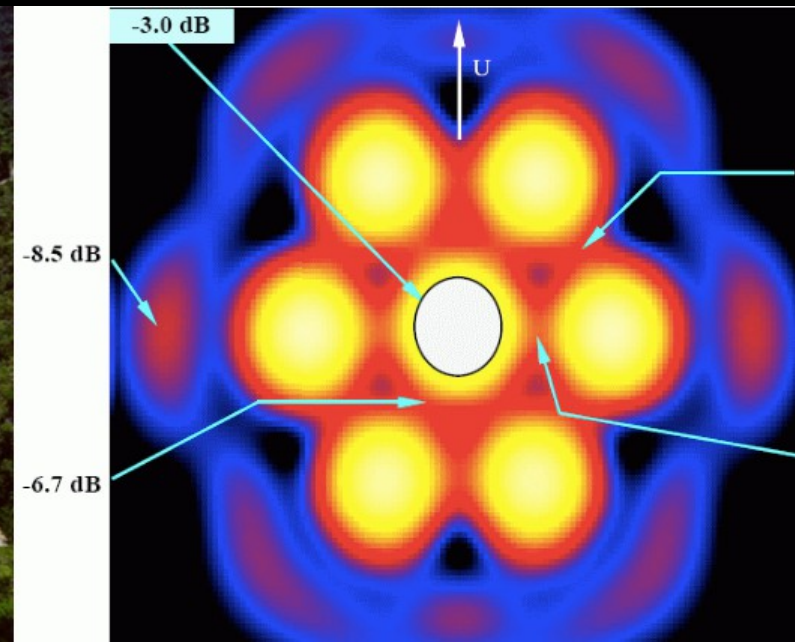
# GBTrans [Ellingson et al.]

- 1.4 GHz / 50 MHz
- Realtime processing
- FRB rate ~1/month?
- Target nearby clusters
- Beginning “shadowing”
  - Swift
  - LIGO
  - Fermi
  - CHIMERA



# FRBs at Arecibo - ALFABURST

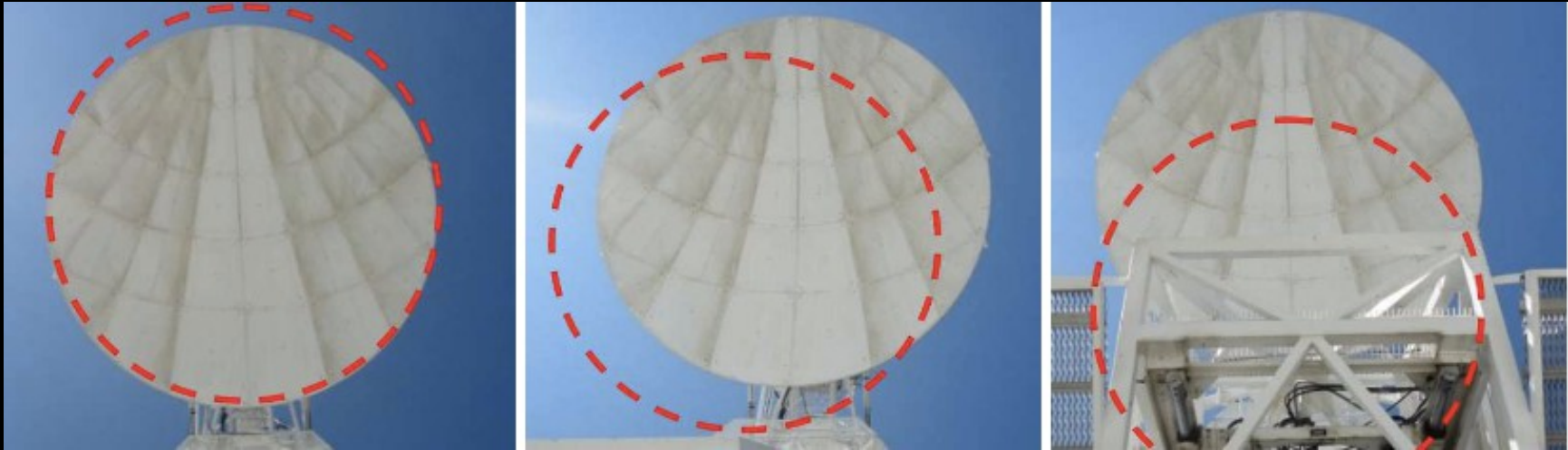
H. Schweiker/WIYN and NOAO/AURA/NSF



- 7 beams - commensal observing
- 56 MHz current bandwidth
- DM range out to 10,000 pc/cc
- Realtime pipeline (similar to Parkes)



# FRBs at GBT - GREENBURST

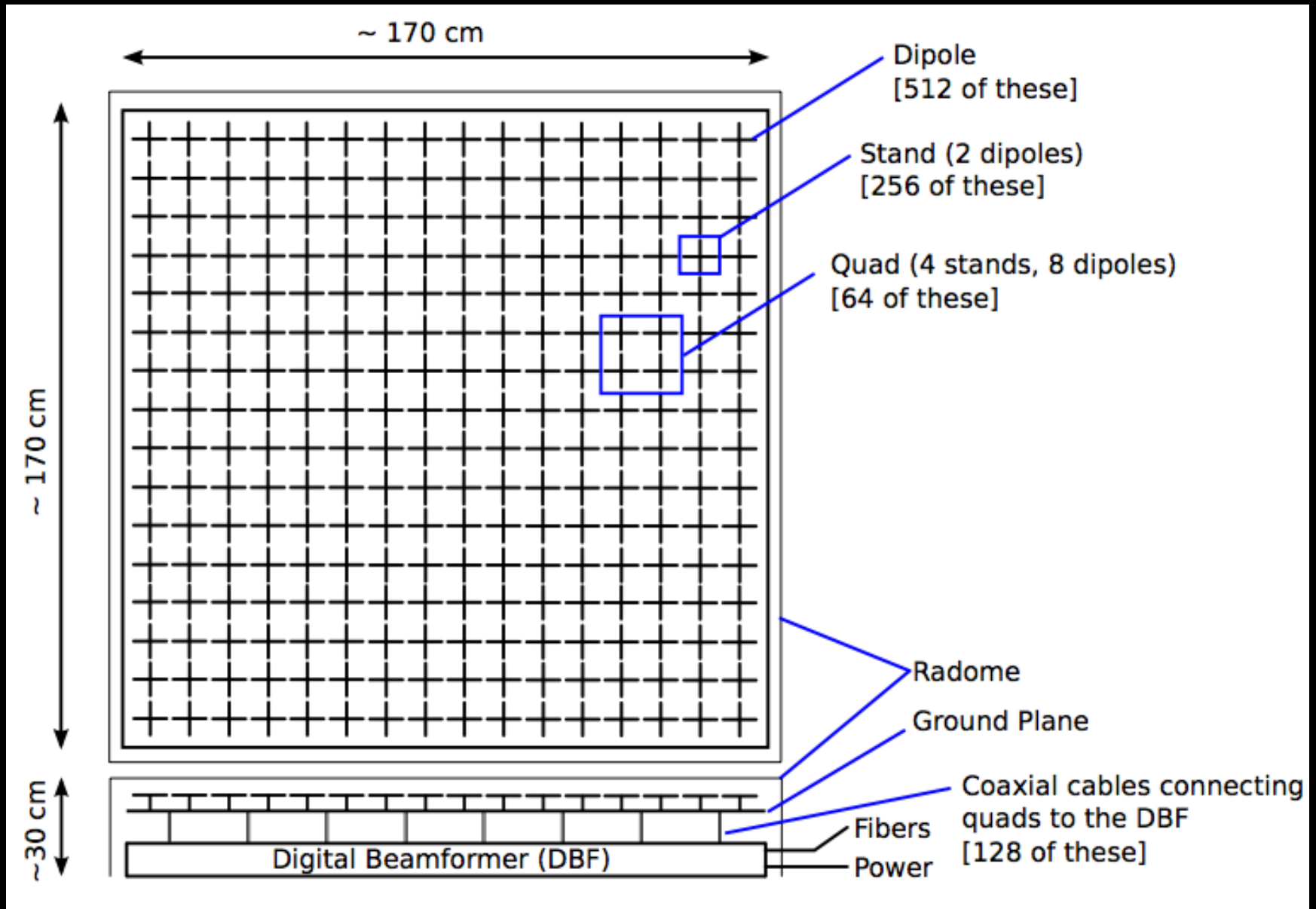


- 1 beams - commensal observing
- Even when other feeds in use!
- 800 MHz current bandwidth
- DM range out to 10,000 pc/cc
- Realtime pipeline

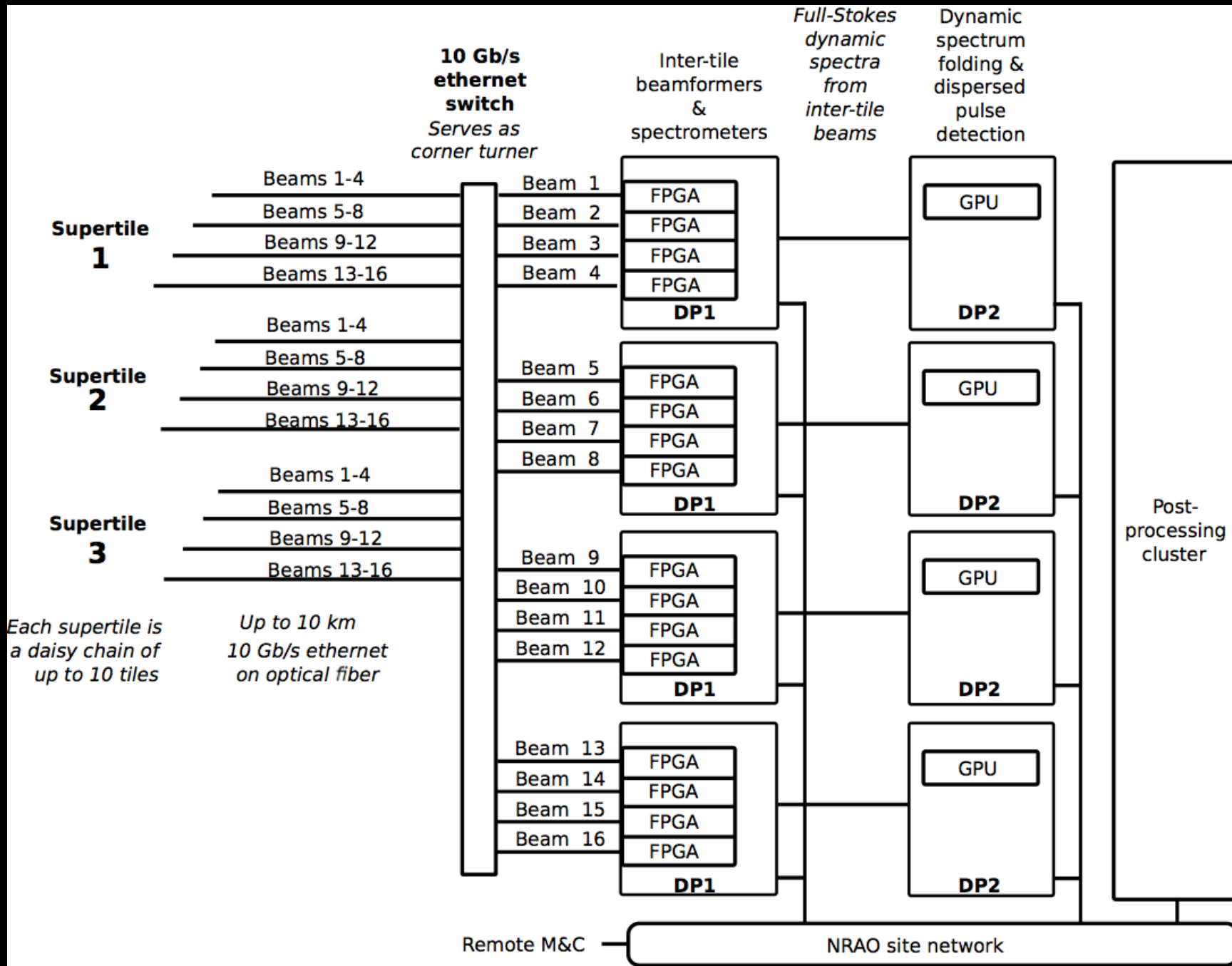
# Strategies going forward

- Single dish surveys
  - FAST
  - FLAG □ FLAG++??
  - ALFABURST □ ALPACA □ ++?
- Broadband single-dish follow-up
  - High sensitivity
  - FRB spectra?
- Shadowing by other arrays?
  - Build something at GB?
  - Make use of RQZ
  - Potential for a PSR telescope?

# L-band Array of Small Arrays (LASA)

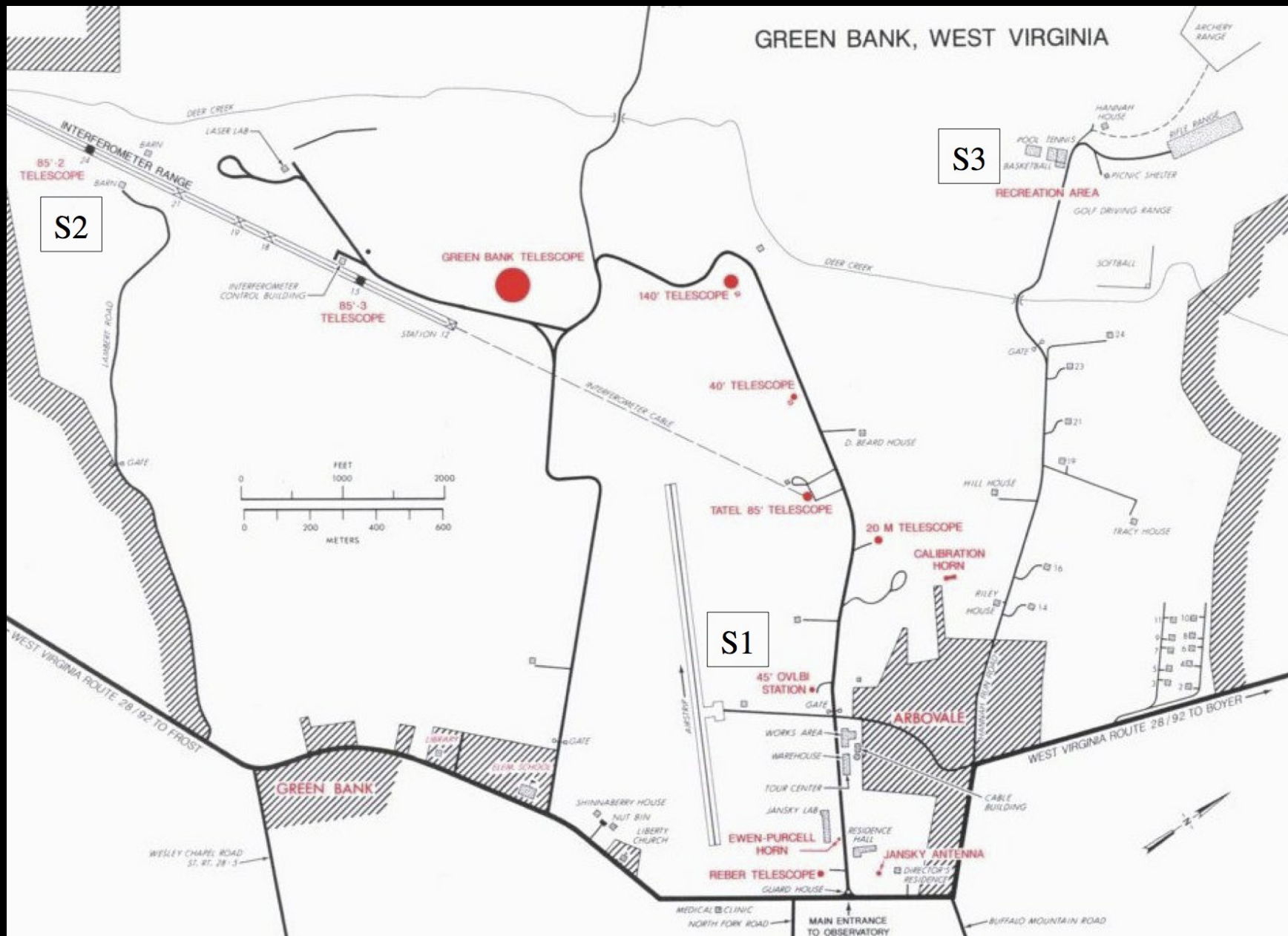


# L-band Array of Small Arrays (LASA)



Credit: Steve Ellingson

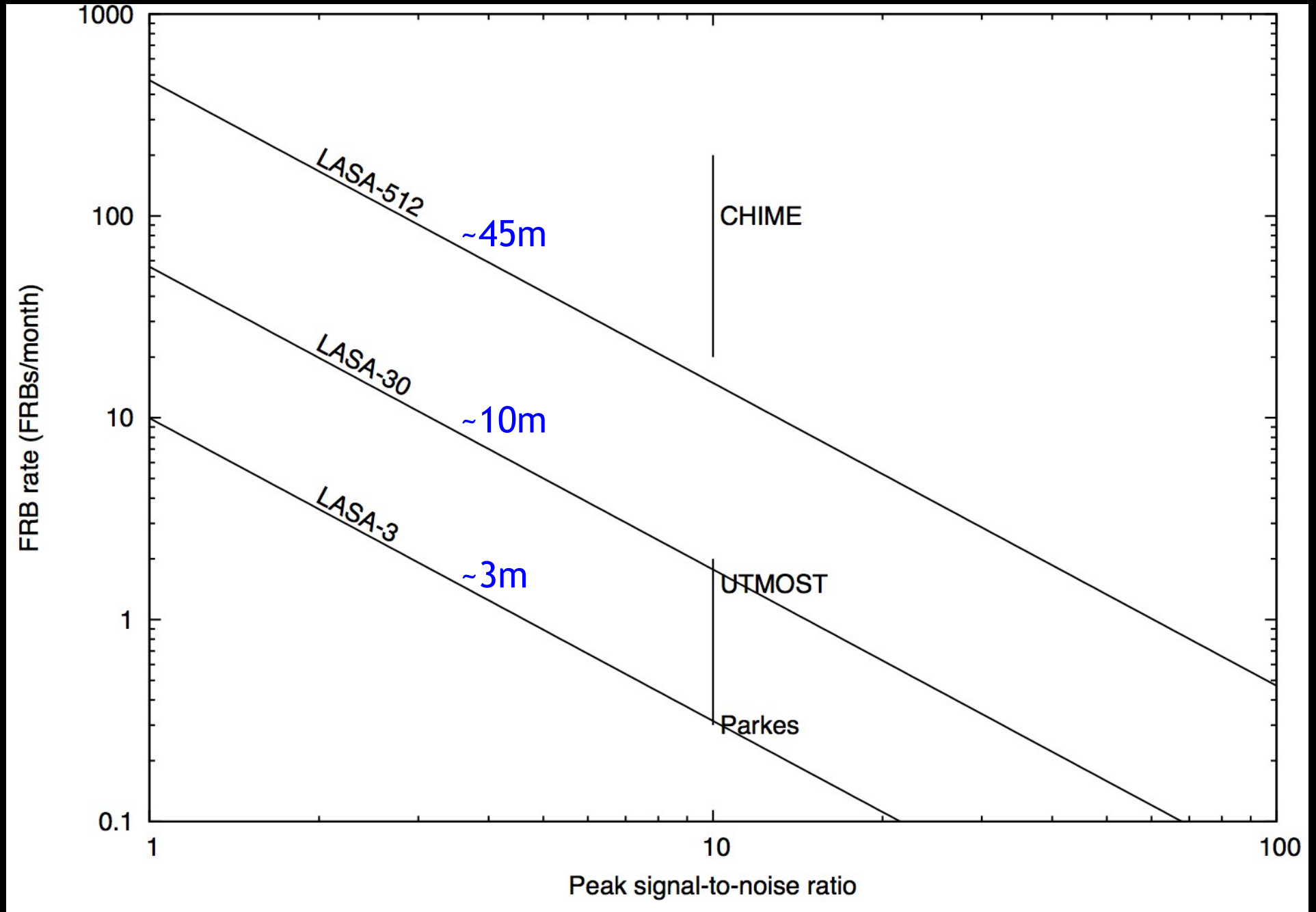
# L-band Array of Small Arrays (LASA)



Credit: NRAO



# L-band Array of Small Arrays (LASA)



# (My) bold predictions

- 2020: 100s FRBs found
  - CHIME
  - REALFAST
  - ASKAP
- 2025: 1000s of FRBs known
  - SKA and its pathfinders
- 2030: FRBs essential cosmological tools
  - Many papers on this already!

