



The Canadian Hydrogen Observatory and Radio-transient Detector

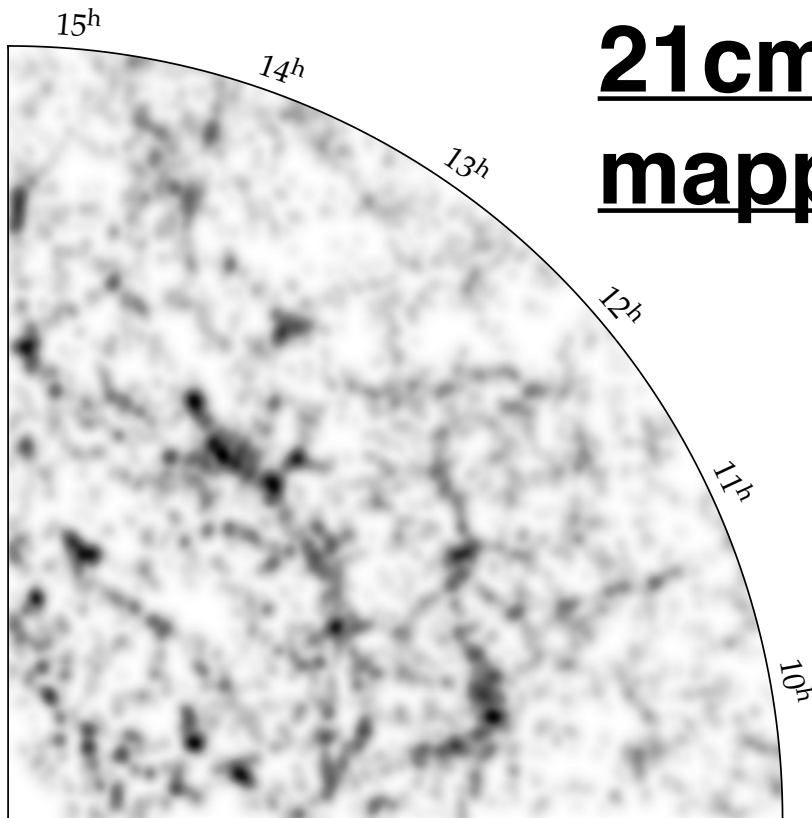
Simon Foreman
Arizona State University

LIM 2025 – June 2, 2025

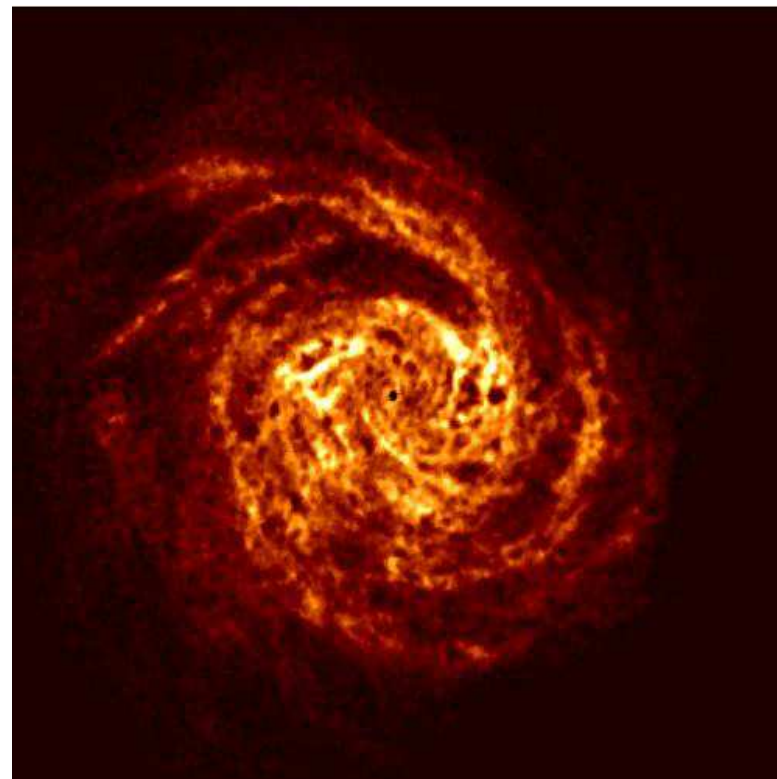


Science goals

21cm intensity mapping

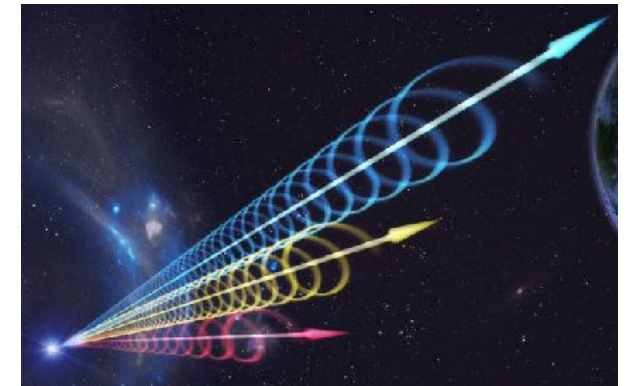


map large-scale structure at BAO scales over $0 \leq z \leq 3.7$ to constrain cosmic expansion history, growth etc.

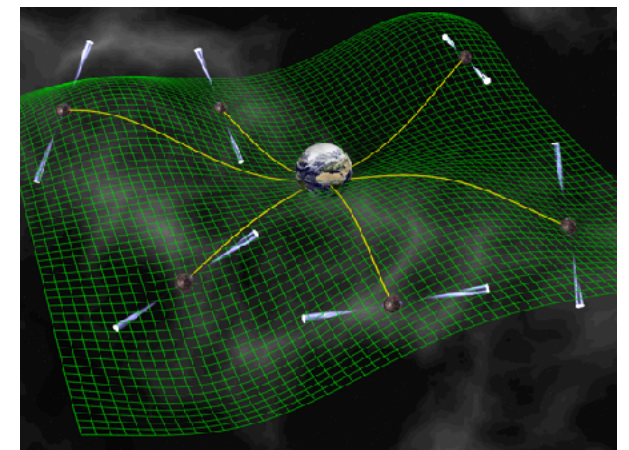


21cm galaxy search

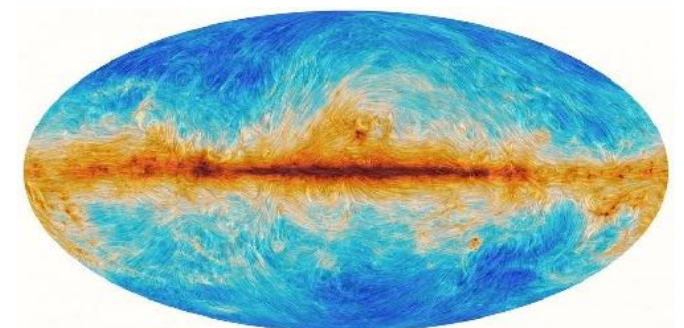
measure 21cm line profiles of $O(10^6)$ low- z galaxies to constrain properties of low-HI-mass galaxies



Fast radio burst search and localization



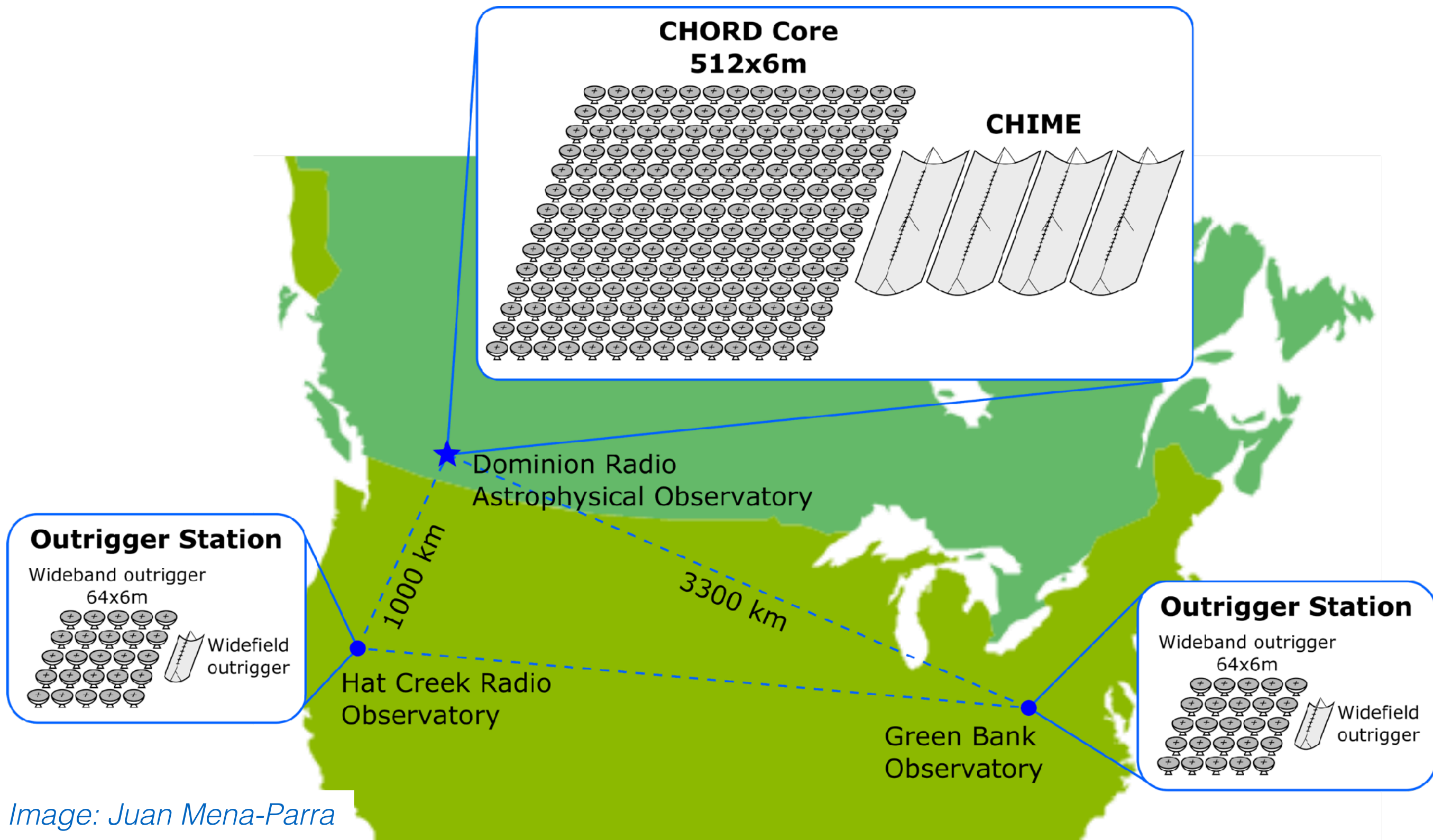
Pulsar search and timing



Cosmic magnetism

CHORD concept

512-dish core + 2 x 64-dish/1-cylinder outriggers



Key properties

		vs. CHIME
Collecting area	14,500 m ²	larger x 2



Image: Tracy Zhuo

Key properties

		vs. CHIME
Collecting area	14,500 m ²	larger x 2
T _{recv}	30 K	lower x 2

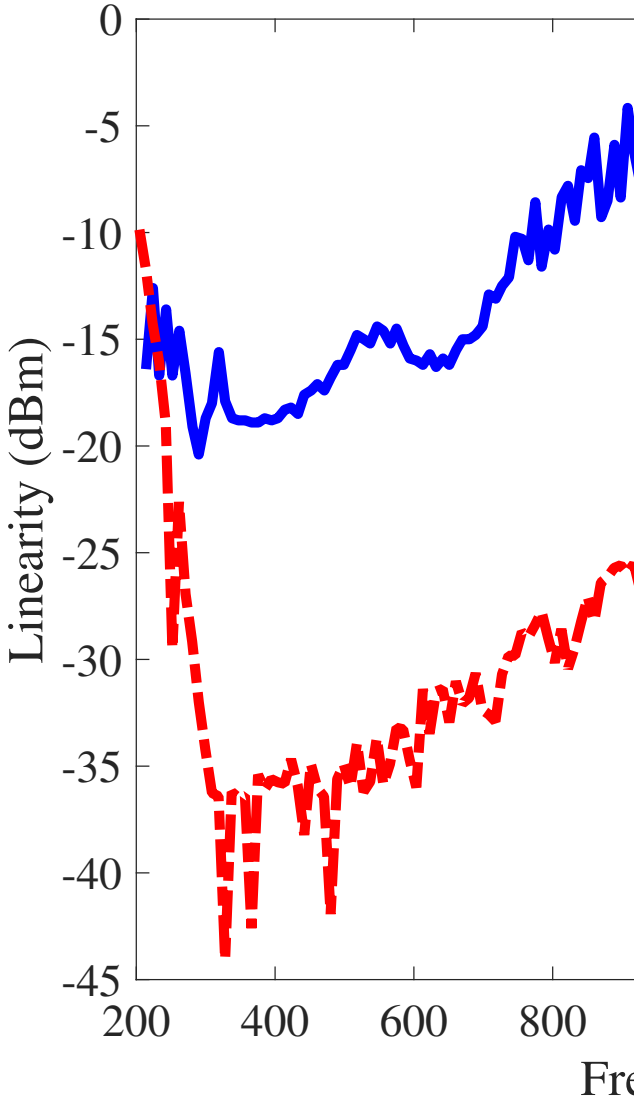
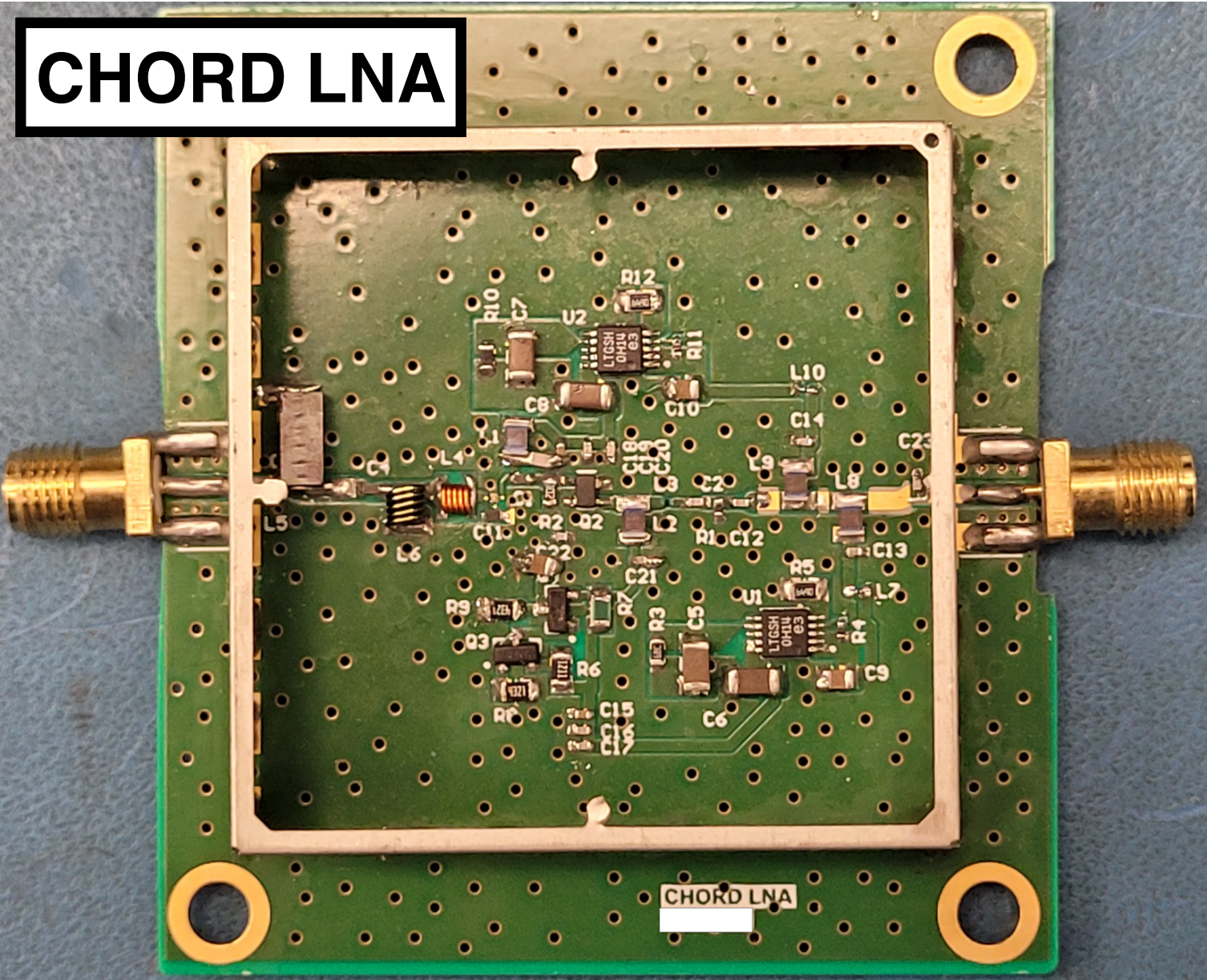
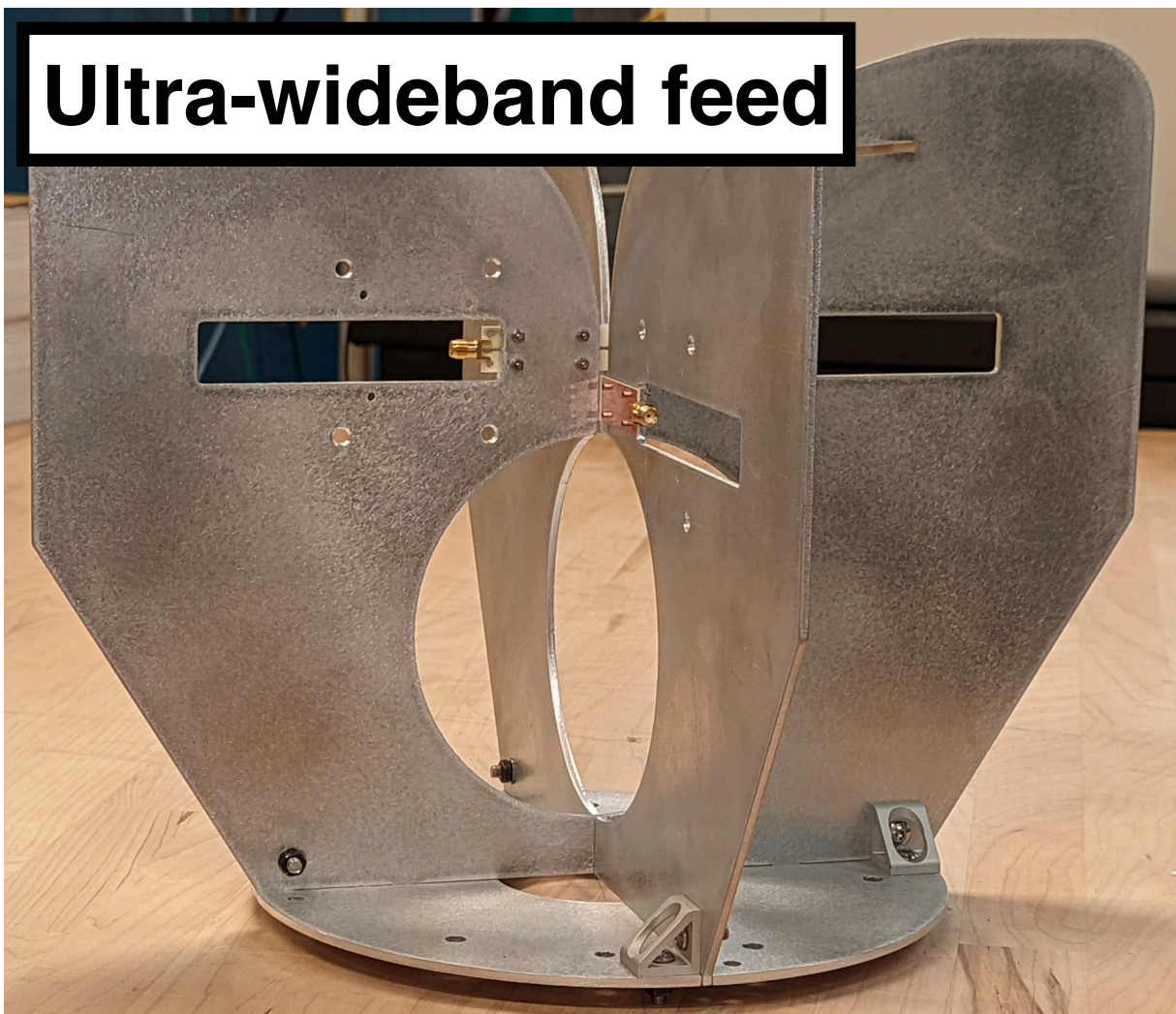


Image: Lai+2023

Key properties

		vs. CHIME
Collecting area	14,500 m ²	larger x 2
T_{recv}	30 K	lower x 2
Band	300–1500 MHz	wider x 3
21cm redshift	$3.7 > z > 0$	$2.5 > z > 0.8$

Ultra-wideband feed



UNIVERSITY OF
TORONTO

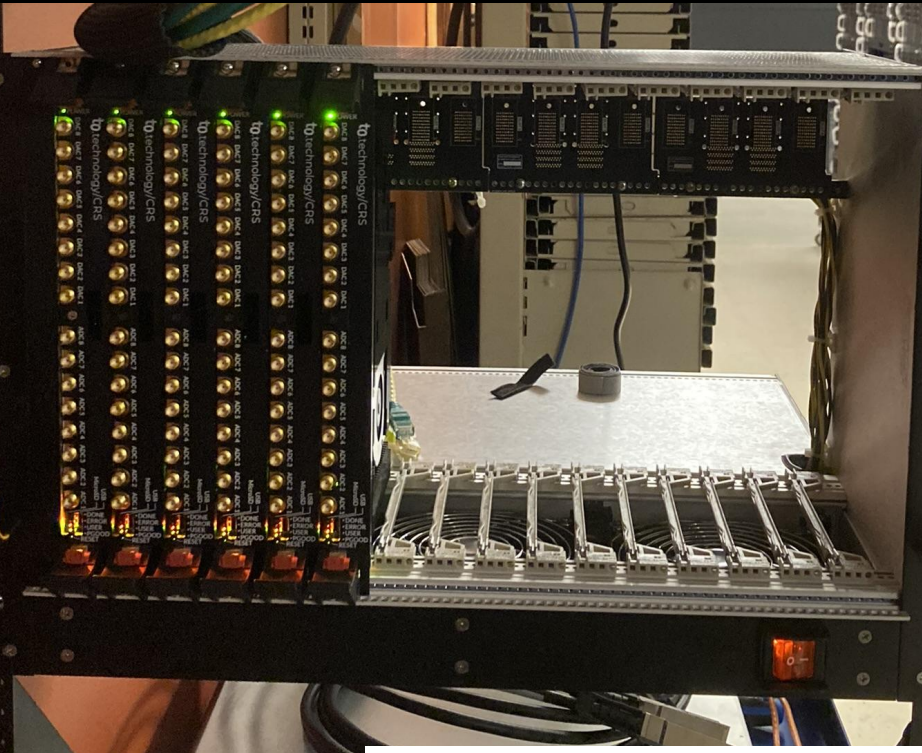
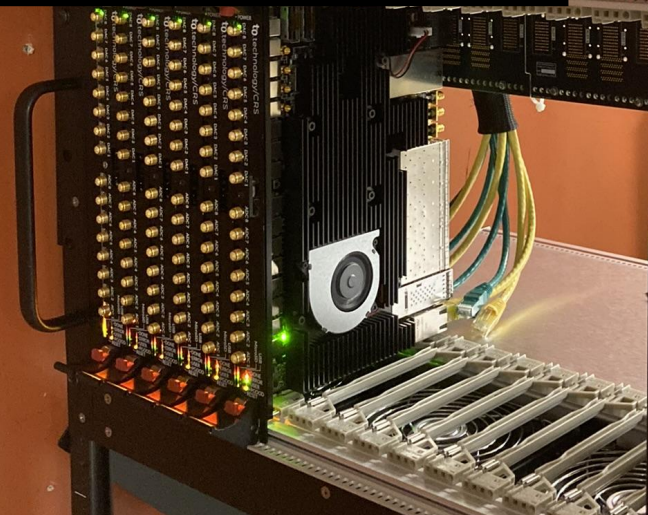
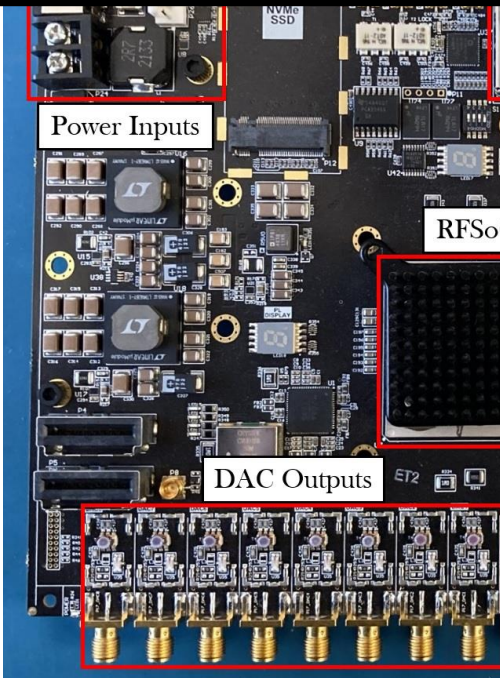
Key properties

		vs. CHIME
Collecting area	14,500 m ²	larger x 2
T _{recv}	30 K	lower x 2
Band	300–	
21cm redshift	3.	
Channel width	1	



GPU-based correlator/
beamformer

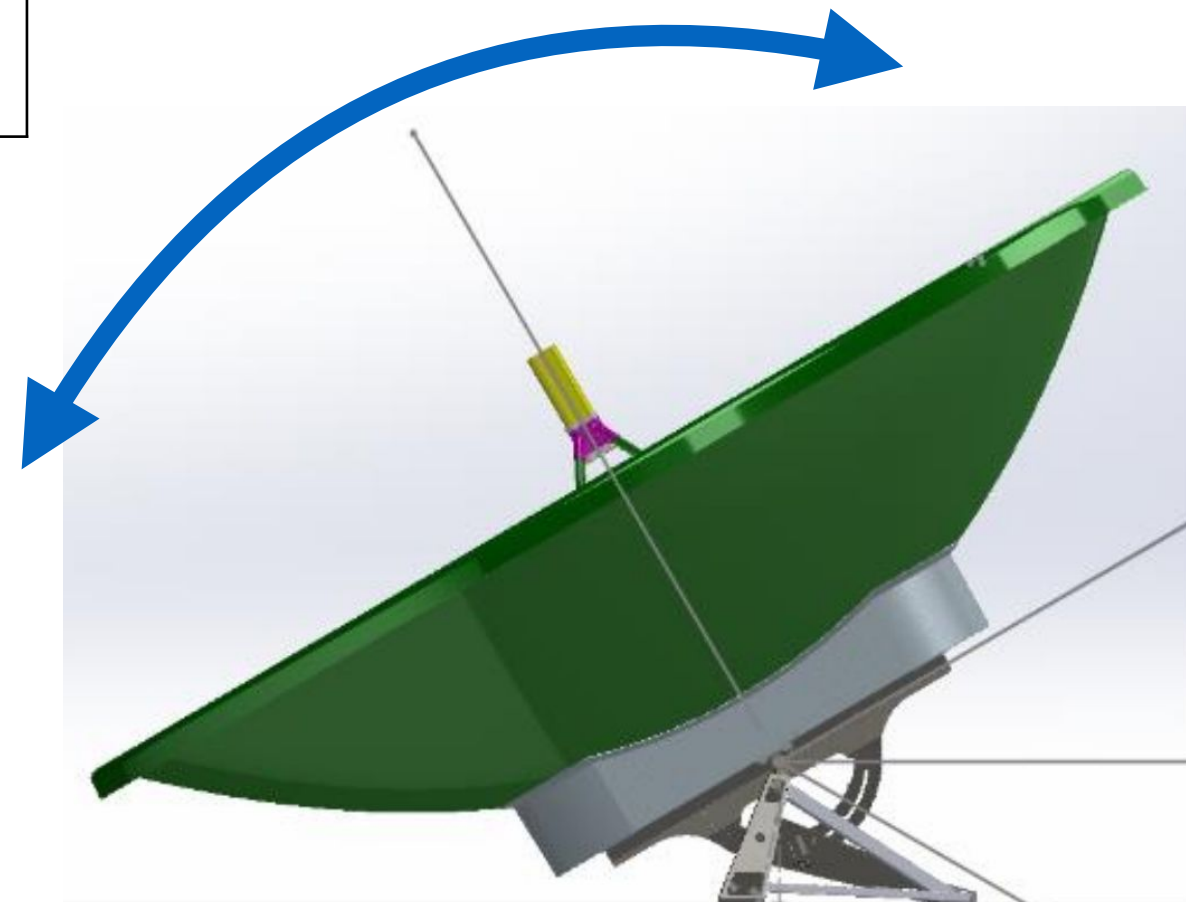
RFSoc digitizer/channelizer



Images: Ian Hendrickson

Key properties

		vs. CHIME
Collecting area	14,500 m ²	larger x 2
T_{recv}	30 K	lower x 2
Band	300–1500 MHz	wider x 3
21cm redshift	$3.7 > z > 0$	$2.5 > z > 0.8$
Channel width	183 kHz	narrower x 2
Survey area	$20^\circ < \text{dec} < 80^\circ$	$\text{dec} \gtrsim -20^\circ$



Key properties

		vs. CHIME
Collecting area	14,500 m ²	larger x 2
T _{recv}	30 K	lower x 2
Band		
21cm redsh		
Channel wid		
Survey are		

- “Deep-dish” (f/0.21) design
 - *Reduced mutual coupling*



Key properties

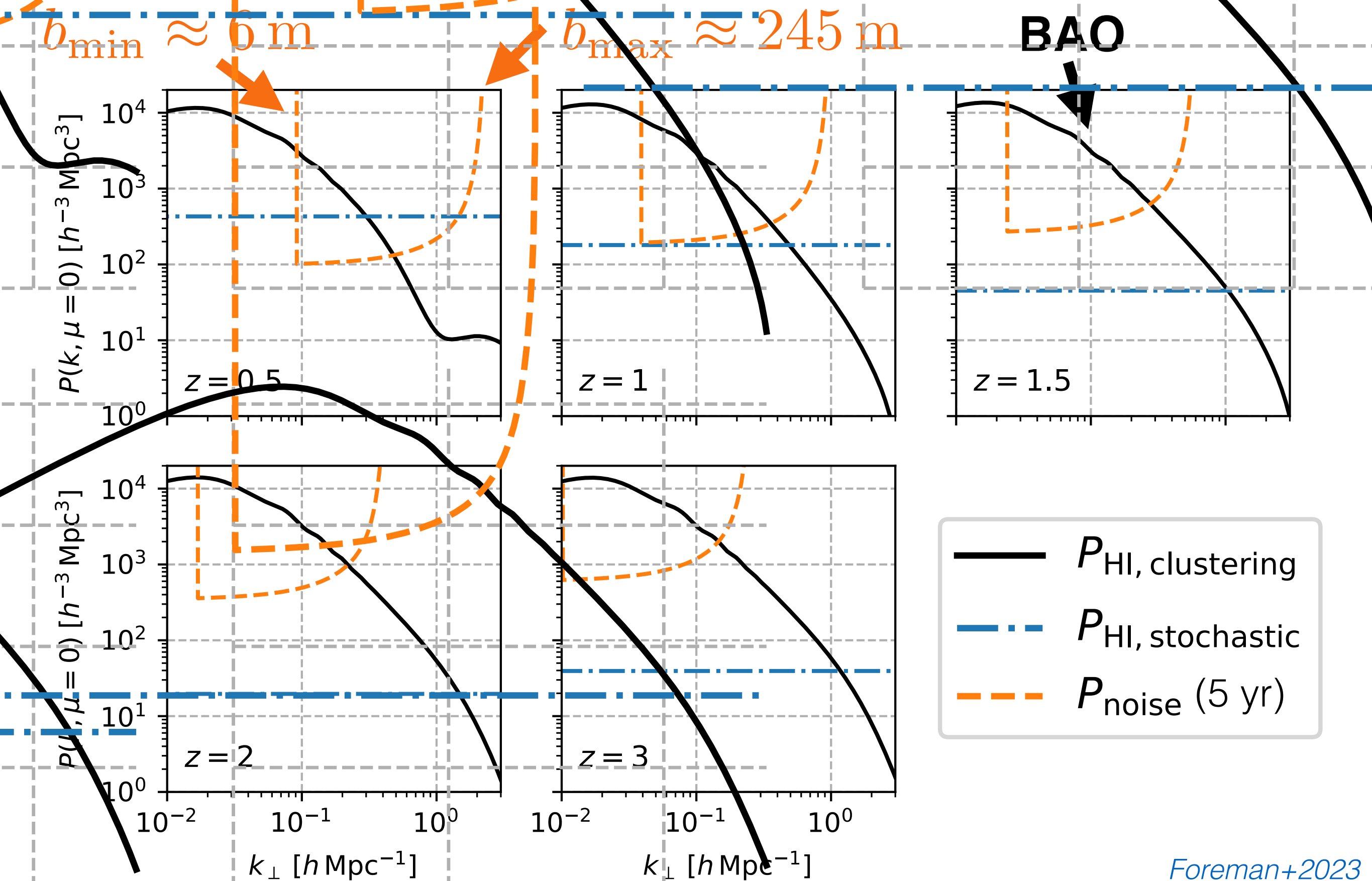
		vs. CHIME
Collecting area	14,500 m ²	larger x 2
T_{recv}	30 K	lower x 2
Band	300–1500 MHz	wider x 3
21cm redshift	$3.7 > z > 0$	$2.5 > z > 0.8$
Channel width	183 kHz	narrower x 2

- “Deep-dish” (f/0.21) design
 - *Reduced mutual coupling*
- Composite dishes manufactured on-site with sub-mm precision
 - *Ease of calibration/beam modelling*



Image: Brian Hoff

HI power spectrum vs. thermal noise

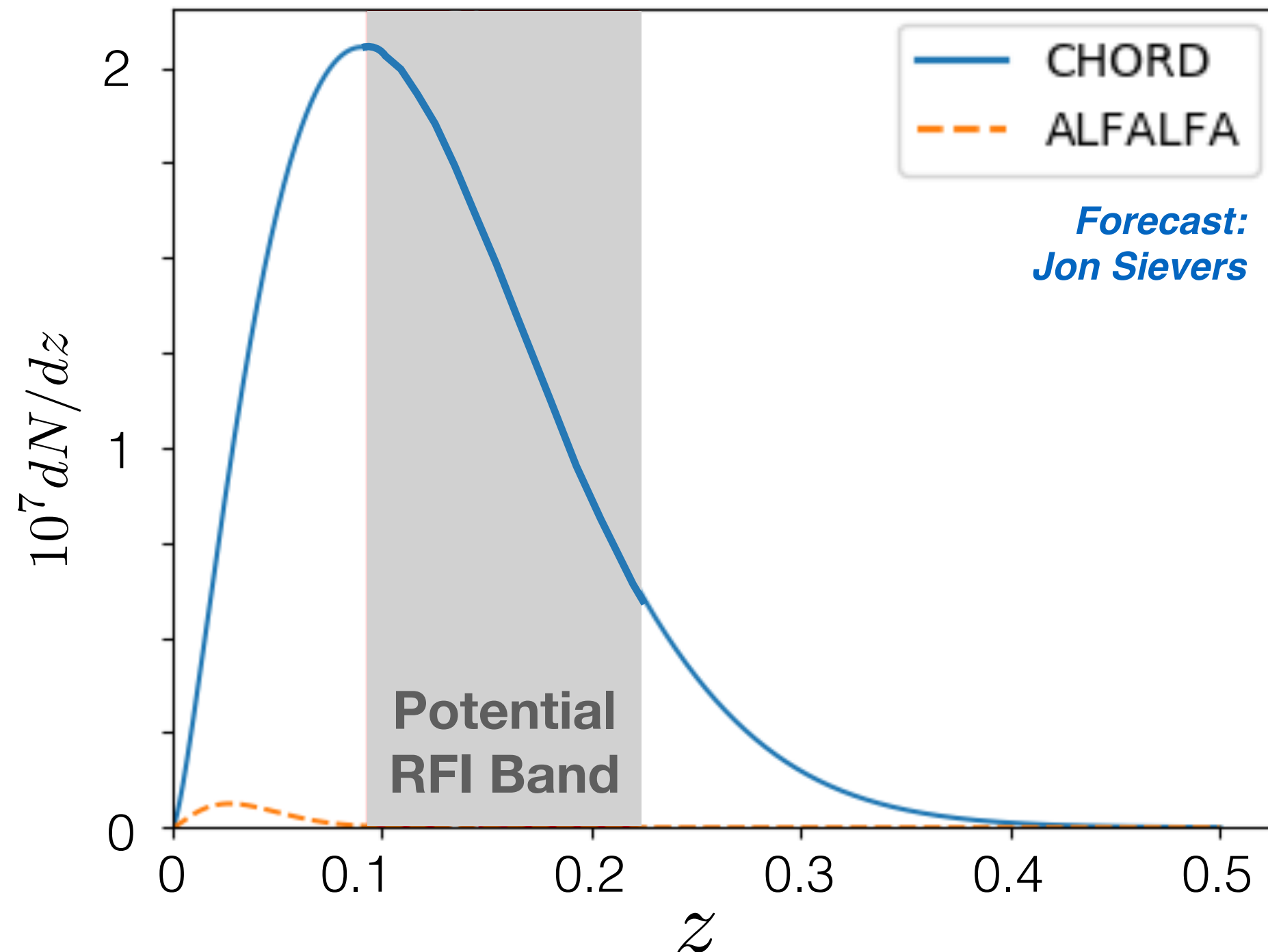


21cm galaxy search

- Forecasted to detect $O(10^6)$ galaxies in local universe

(100x ALFALFA)

- HI mass function
- cross-matching with DESI BGS
- ...



- **Opportunity:** connecting direct measurements of 21cm galaxies with LIM modelling (e.g. linear bias)

Timeline

2025:

end-to-end testing of
first dishes+signal chain

2026:

commissioning of 64-dish
pathfinder

>2026:

completion of 512-dish
array and commencement
of science operations

First dish deployed (03/2025)



Image: Brian Hoff

Conclusions

- **CHORD**: close-packed core of 512 6m dishes + outrigger stations
- **Designed to minimize systematic errors** (mutual coupling, element non-redundancy)
- **Goals:**
 - 21cm IM over $0 \lesssim z \lesssim 3.7$
 - 21cm galaxies at $z \lesssim 0.1$
 - FRB search/localization
 - Pulsar search/monitoring
 - Galactic magnetic fields
- **64-dish pathfinder online next year**

