HIRAX: Plans and Prototypes

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HIRAX: The Basics

The Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX) is a transiting interferometric radio telescope array that will be built in the Karoo desert in South Africa.

SPECS:

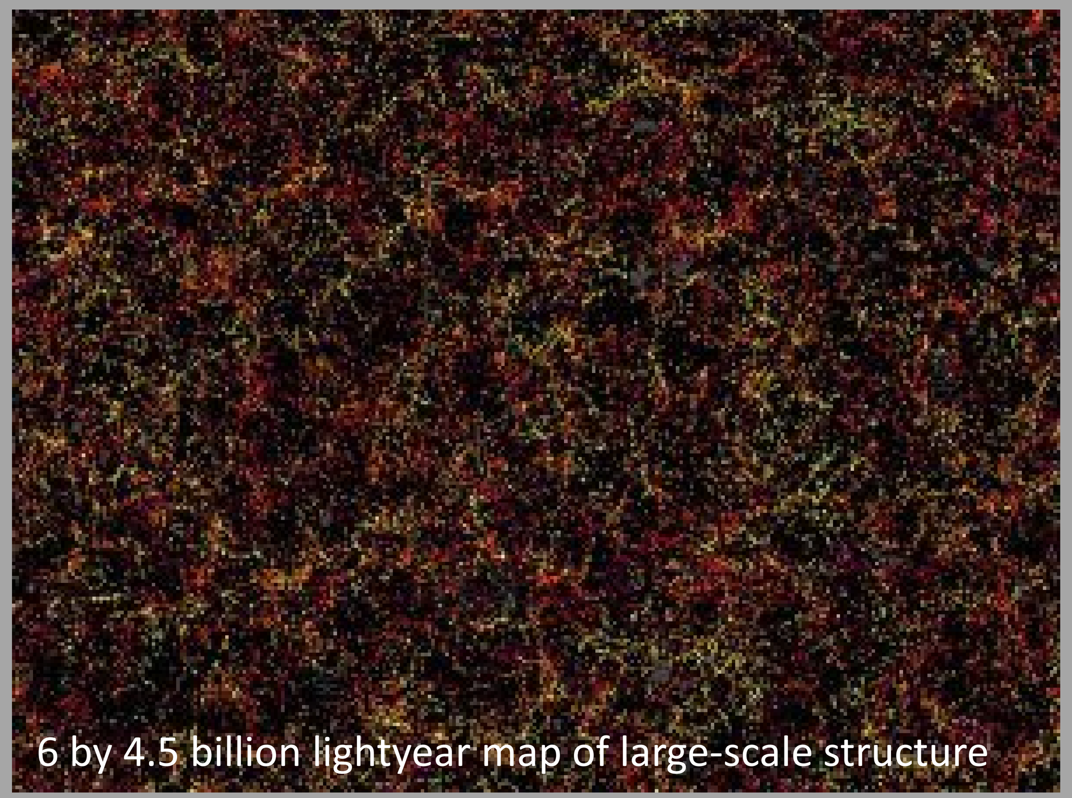
- made of 1024 6m diameter dishes
  - total collecting area of $28000m^2$
- frequency range 400 to 800 MHz
  - redshift of 0.8 to 2.5
- 5-10 deg instantaneous field of view

Image of prototype dish

HIRAX will go on to observe about 15,000 square degrees of the sky in the Southern Hemisphere.

Science Goals

- Hydrogen intensity mapping to study dark energy
  - Baryon Acoustic Oscillations (BAOs): sound waves in the early universe frozen into place when things cooled
- Find and pinpoint fast radio bursts (FRBs)
  - Sister experiment to CHIME in northern hemisphere
- Find radio transients and pulsars



6 by 4.5 billion lightyear map of large-scale structure

Image credit*:* Daniel Eisenstein and SDSS-III

The Big Challenge: Everything ~~is~~ SHOULD BE exactly the same

How absolutely identical can we make each antenna in the array? How identical do they *need* to be?

Many aspects to consider:

Dish uniformity:

- How much can the shape of the dish vary? The pointing of the dish? What if the dish mount settles?

Feed uniformity:

- Not only needs to be the same during manufacturing, must be positioned the same way inside each dish

Uniform baselines:

- Spacing and positioning must be exact, and cabling to the dishes must avoid introducing uneven time delays

Why Redundancy is Relevant

Benefits of a redundant array: easier to deal with data

- 6.5 Tb of data per second in full array mode!
  - Average together visibilities from identical baselines
  - The more redundant the array is the less data storage and post processing has to be done
    - Tradeoff between redundancy and dealing with larger, more complex volumes of data that affect science goals

My piece of the puzzle

I work mostly with a two element test bed at Dominion Radio Astrophysical Observatory (DRAO) near Penticton, Canada. This includes two 3 m dishes and access to one 26 m dish.

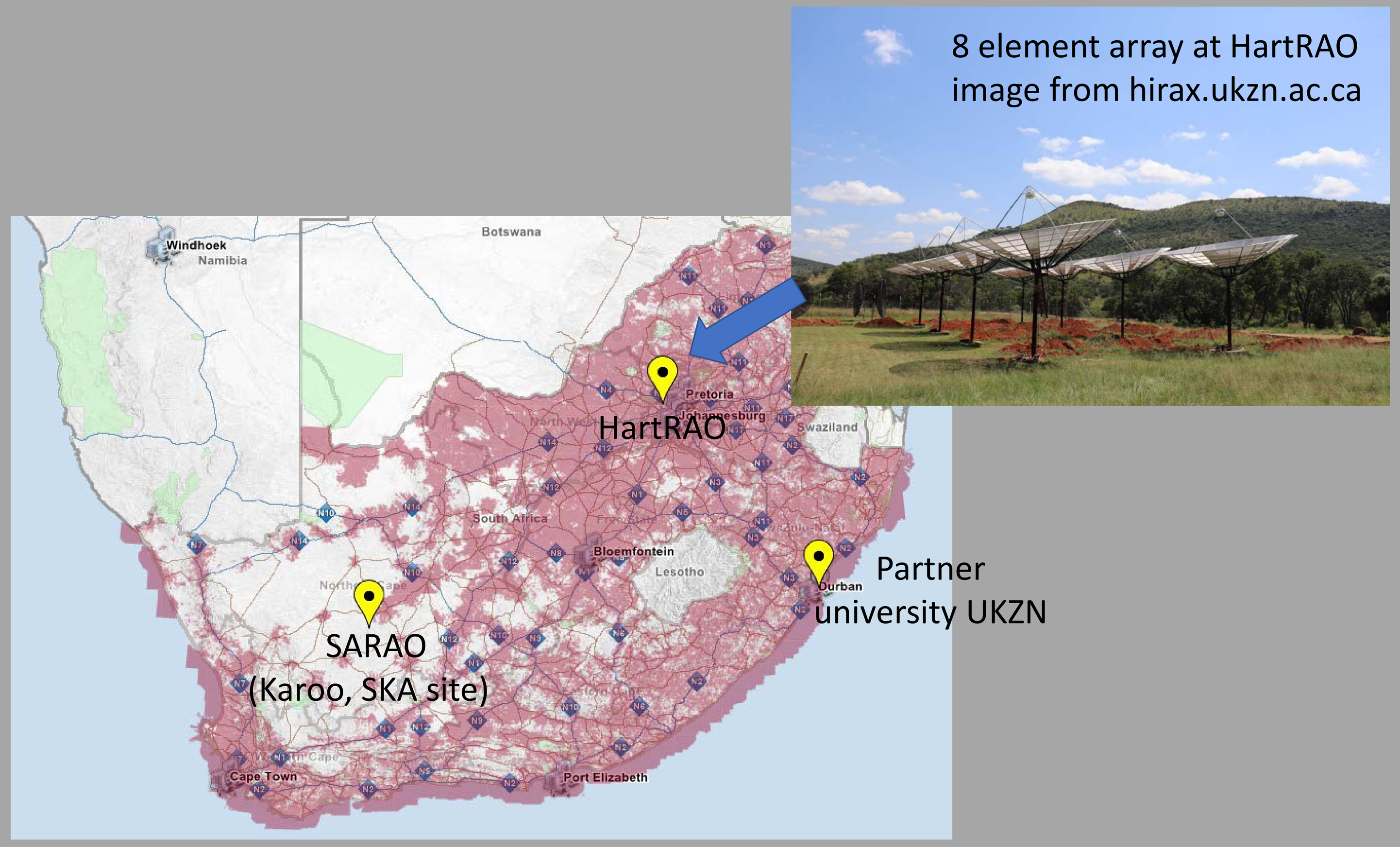
- Various calibration tasks:
  - **Beam cuts:** responses of the 3 m dishes as a source moves across their field of view. Do they match?
  - **System noise temperature**: trying to identify source of greatest noise temperature (feed, dish, electronics)
    - Hope to characterize electronics in lab soon that were at DRAO

Other work: CST simulations tweaking various aspects of the full HIRAX dish.

Current HIRAX prototypes

- 2 element array DRAO
- 8 element array HartRAO, South Africa
- 256 element array in progress for SARAO, South Africa

Then: 1024 dishes at SARAO, South Africa!



Map from C. Chiang