

# DINGO's Walkabout Through the Deep HI Universe



International  
Centre for  
Radio  
Astronomy  
Research

an

**ASTOUNDING**  
STORIES  
OF SUPER-SCIENCE

narrated by

Attila Popping



THE UNIVERSITY OF  
WESTERN AUSTRALIA  
*Achieve International Excellence*

Inaugural Symposium of Super Science Fellows

Hobart, 18-20 April 2012





WALT DISNEY

# SUPER-DINGO

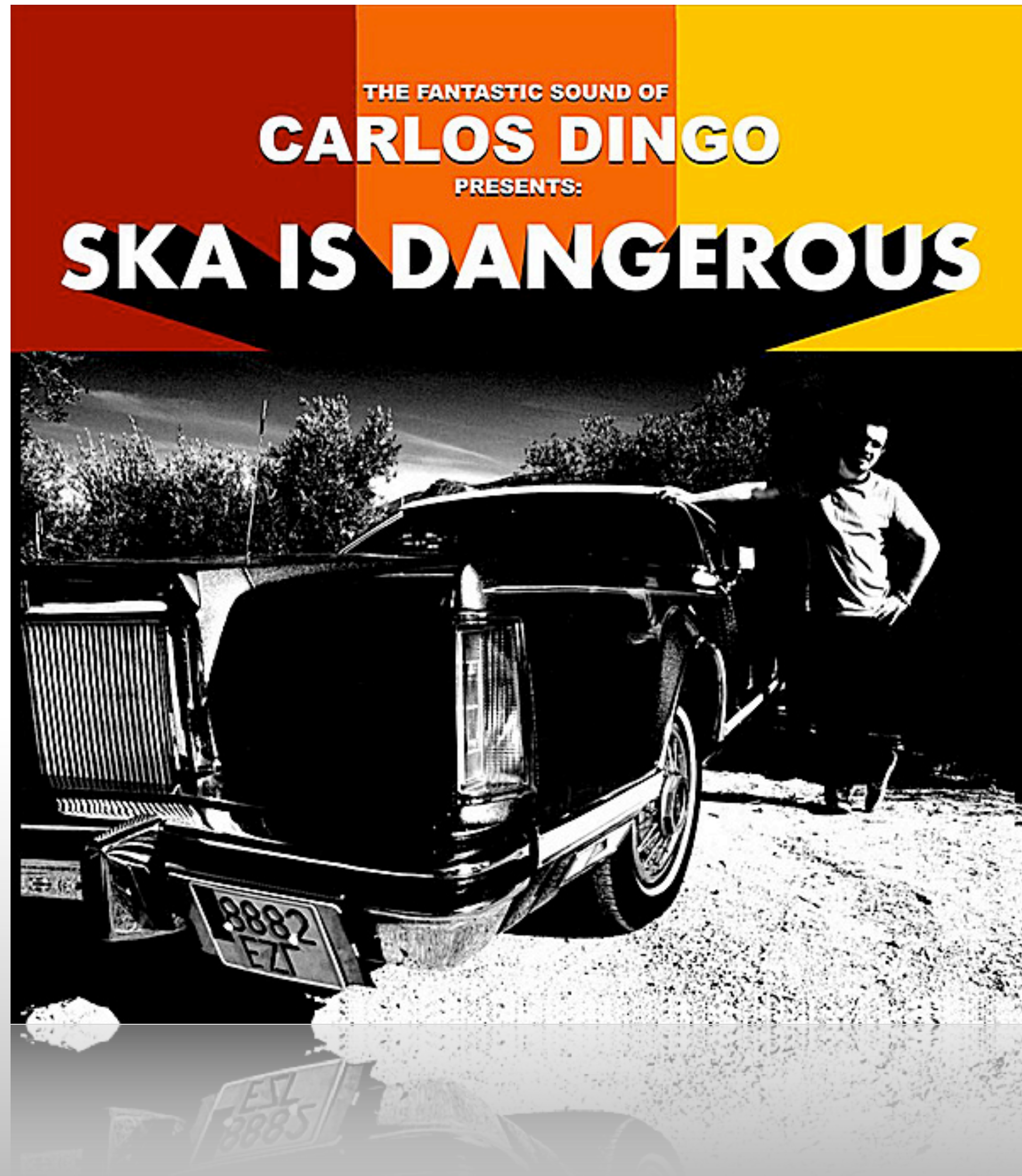


16

22







The SKA is in a very difficult process of the final site selection, no further comments ....

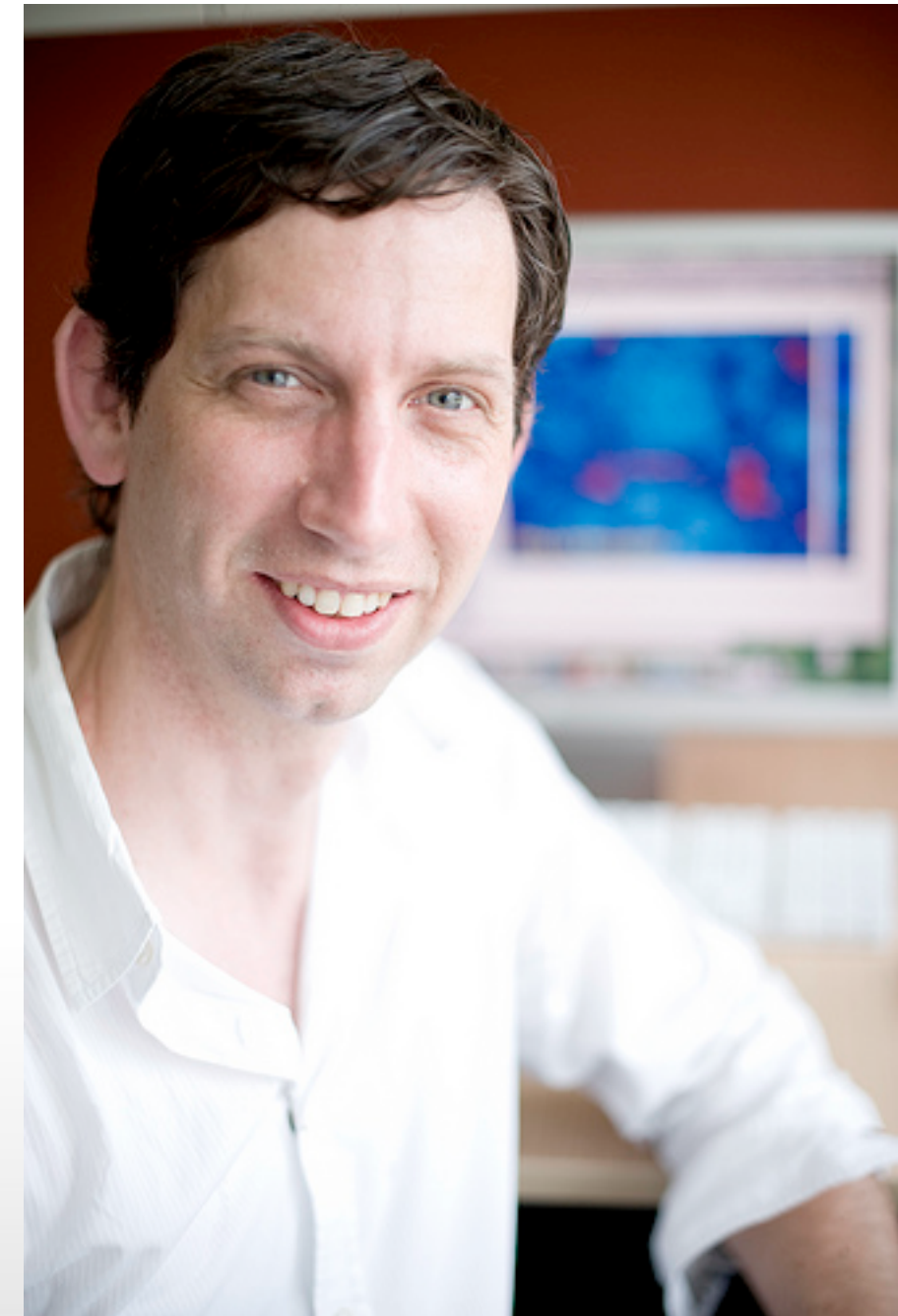




# Deep Investigations of Neutral Gas Origins

## DINGO

## The Dingo Master



PI: Martin Meyer

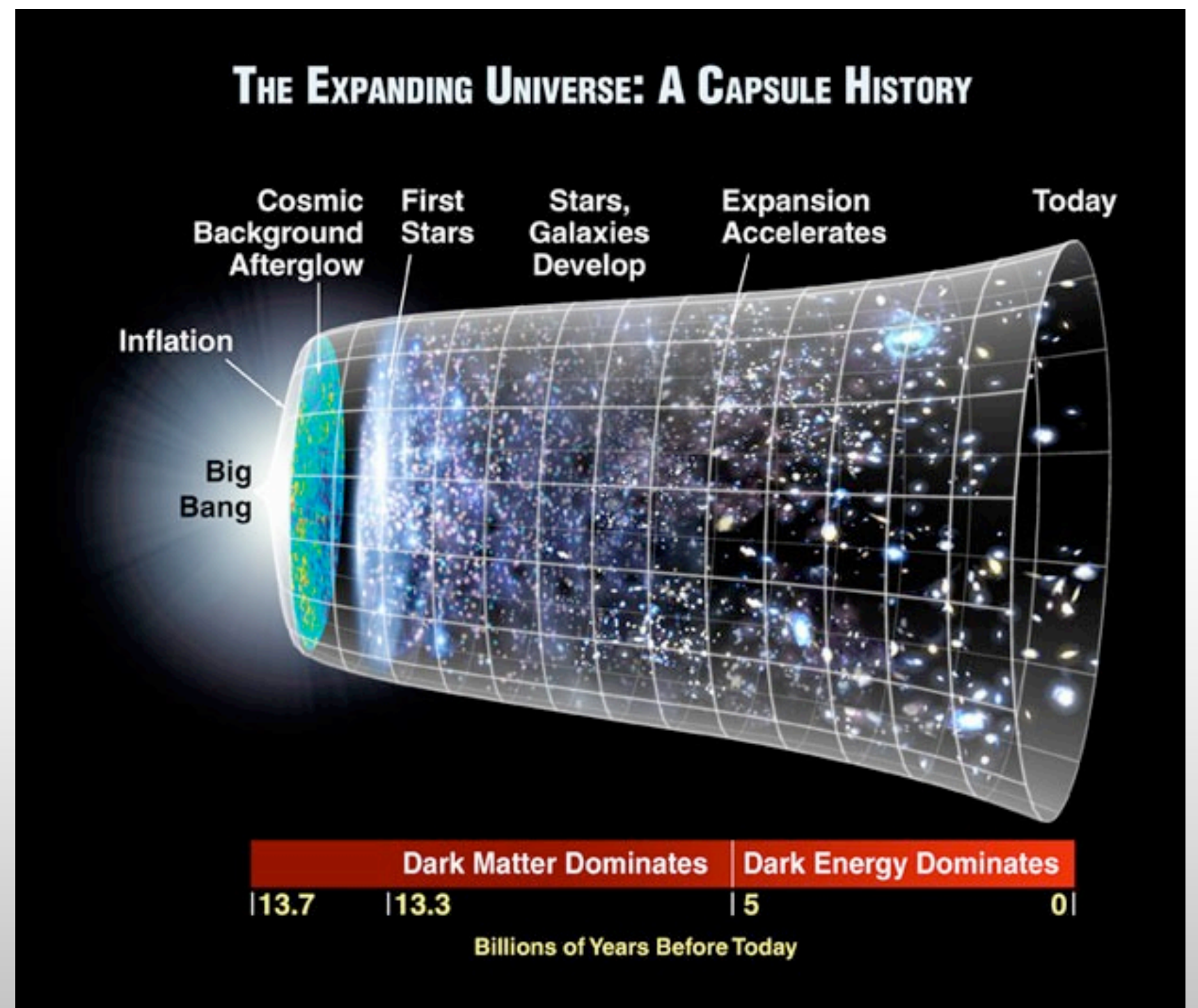
- One of the ASKAP Survey Science Projects
- Deep HI survey on ASKAP

Dingo's walkabout: A long journey through unknown space on an unknown telescope





# Importance of HI







# Importance of HI

Fundamental galactic ingredient

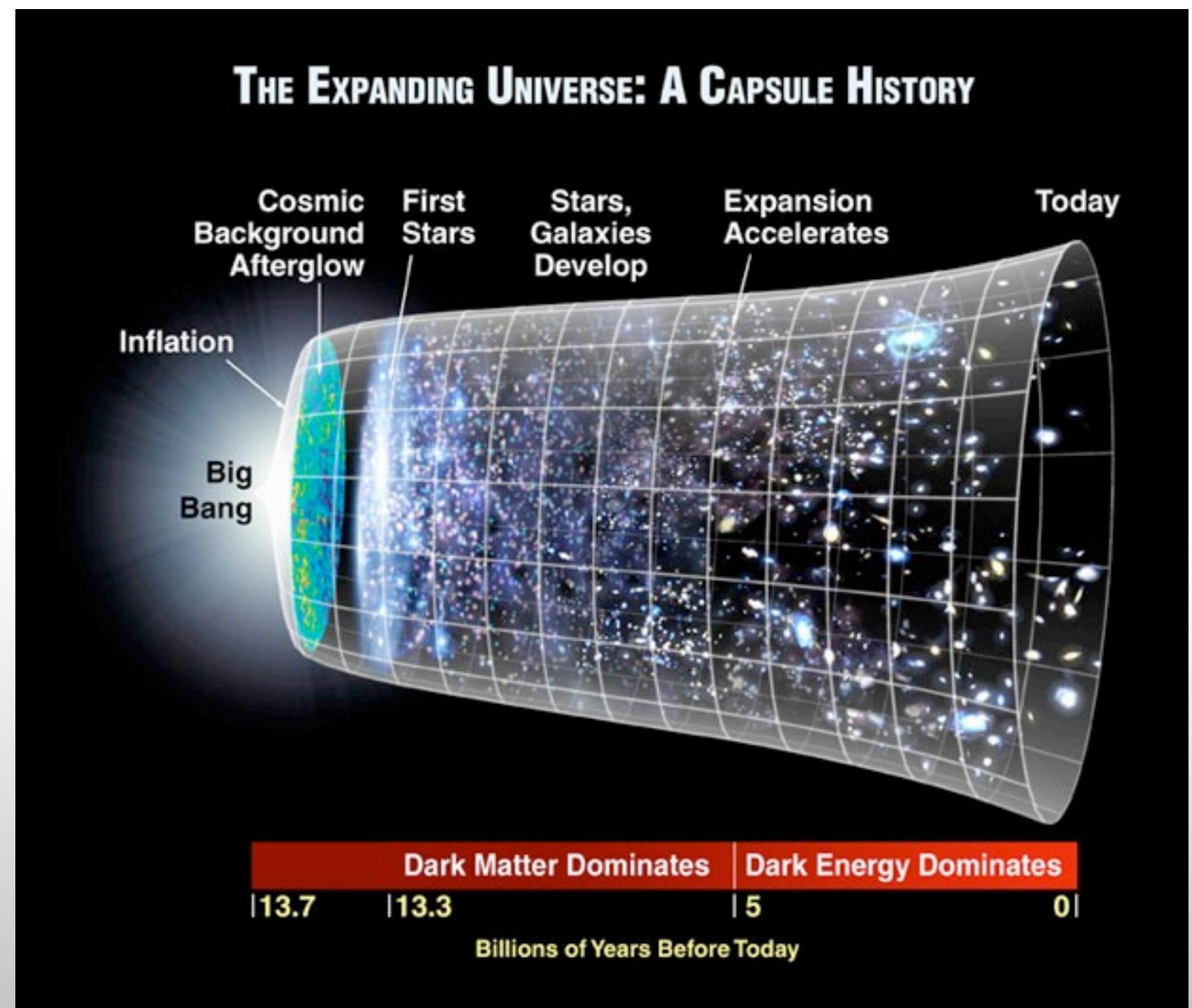
Fuel for star formation

Tracer of galaxy kinematics

Tracer of environmental

Optically thin, direct interpretation

Alternate window on universe

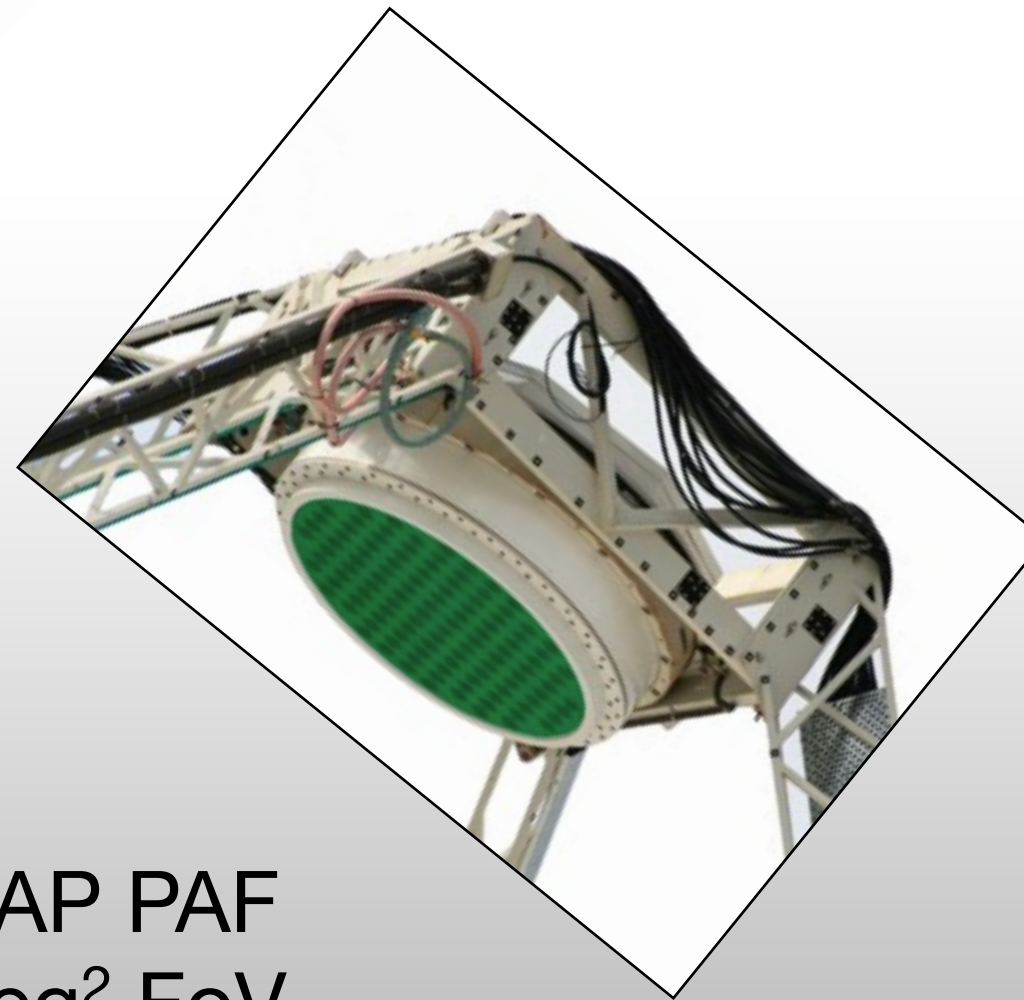
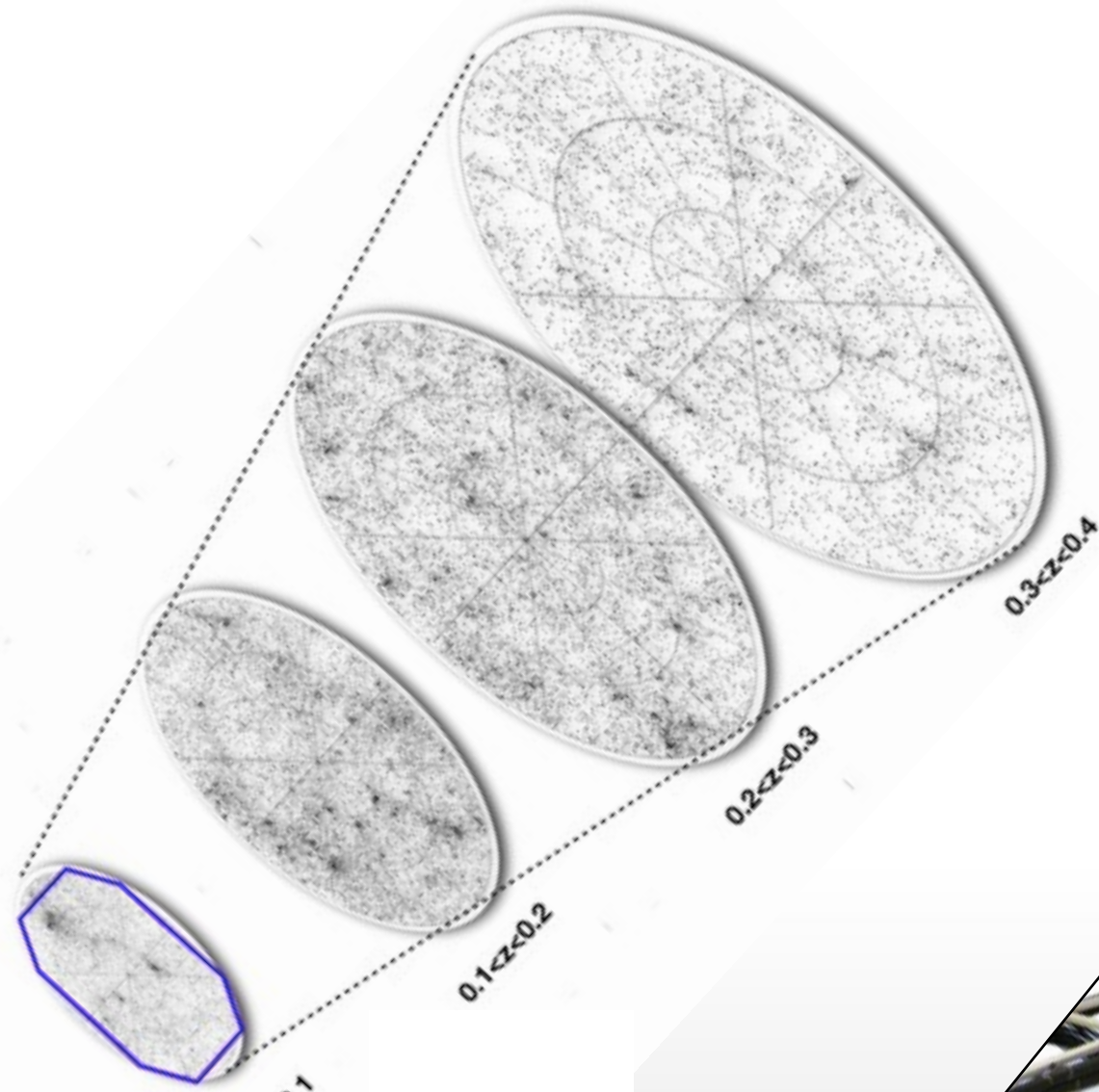






## DINGO Configuration:

- **UDEEP**: ~50k gals, 2 fields (60 deg<sup>2</sup>), 0.1 < z < 0.43, 2500 hours/field
- **DEEP**: ~50k gals, 5 fields (150 deg<sup>2</sup>), z < 0.26, 500 hours/field



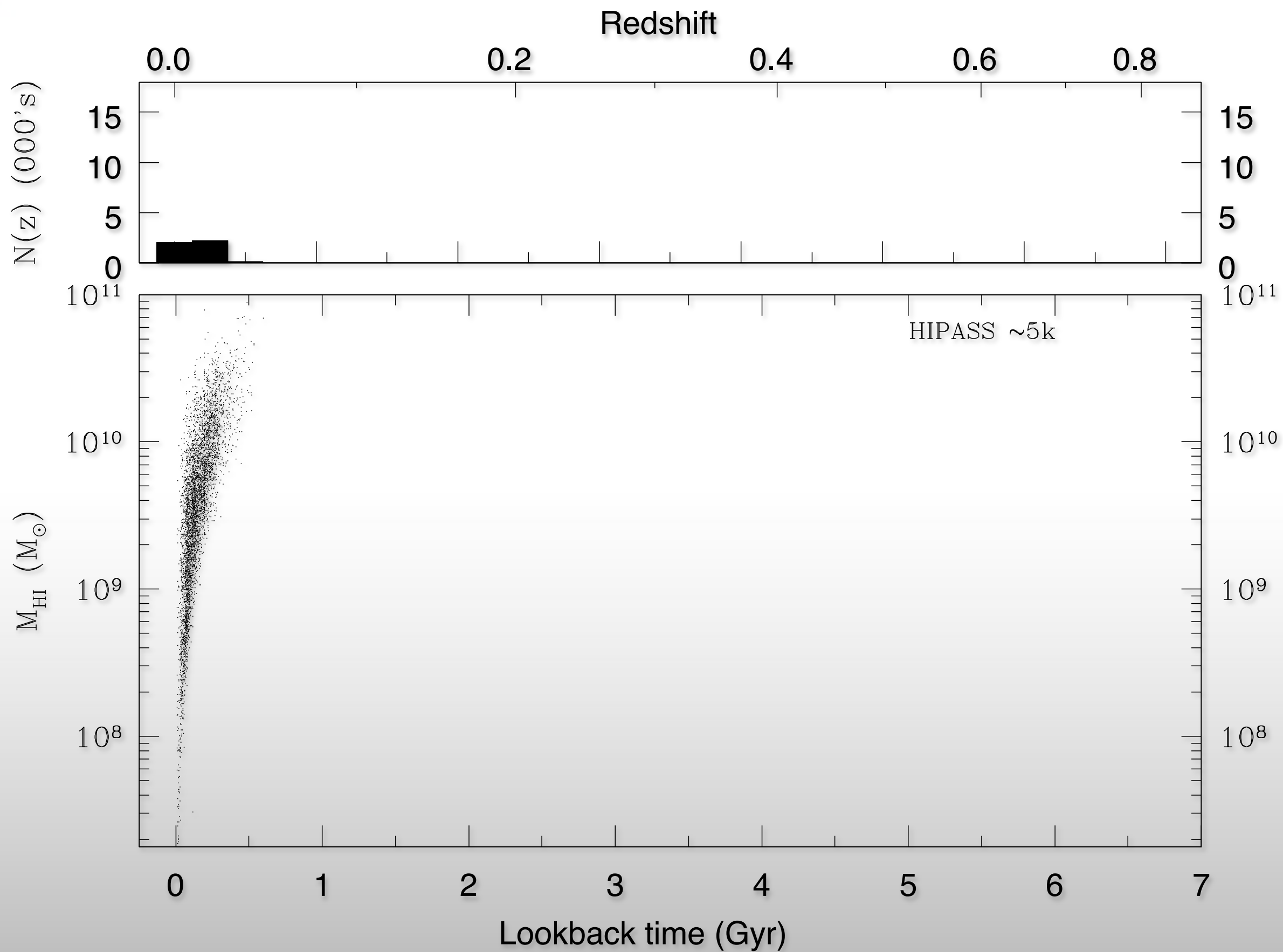
ASKAP PAF  
30 deg<sup>2</sup> FoV







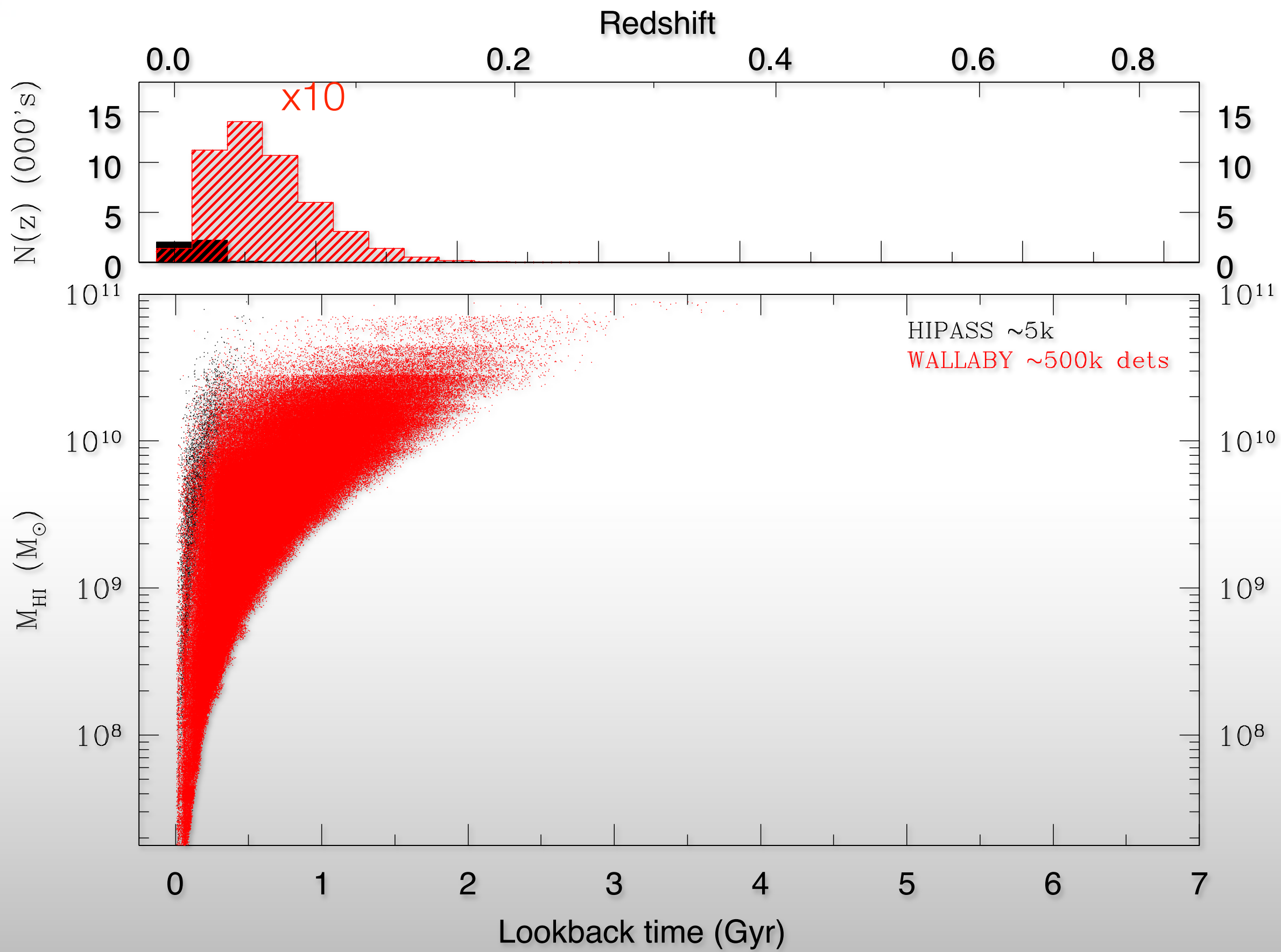
# ASKAP HI Surveys







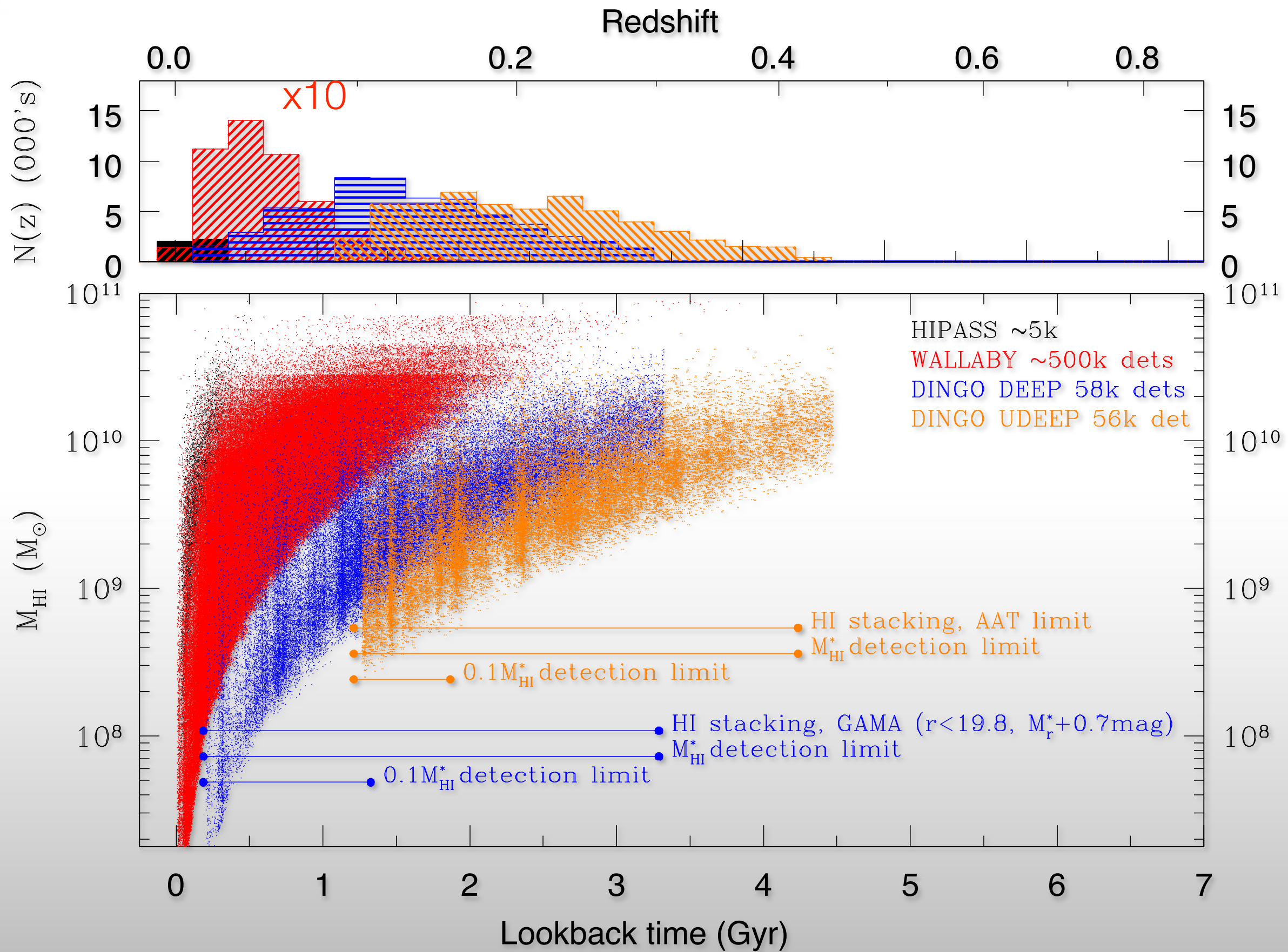
# ASKAP HI Surveys







# ASKAP HI Surveys

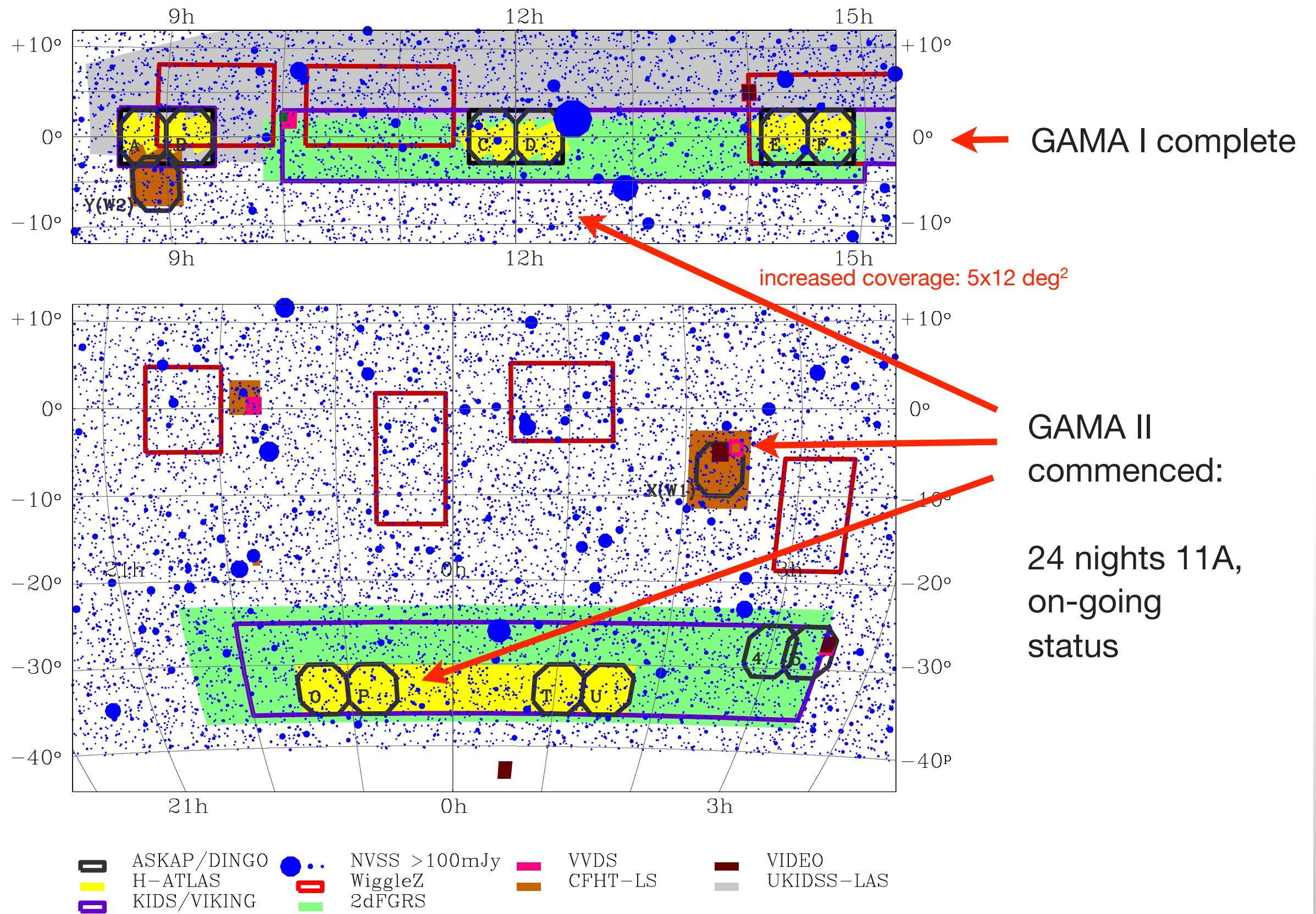






# Where will DINGO look ?

Do commensal science with other surveys



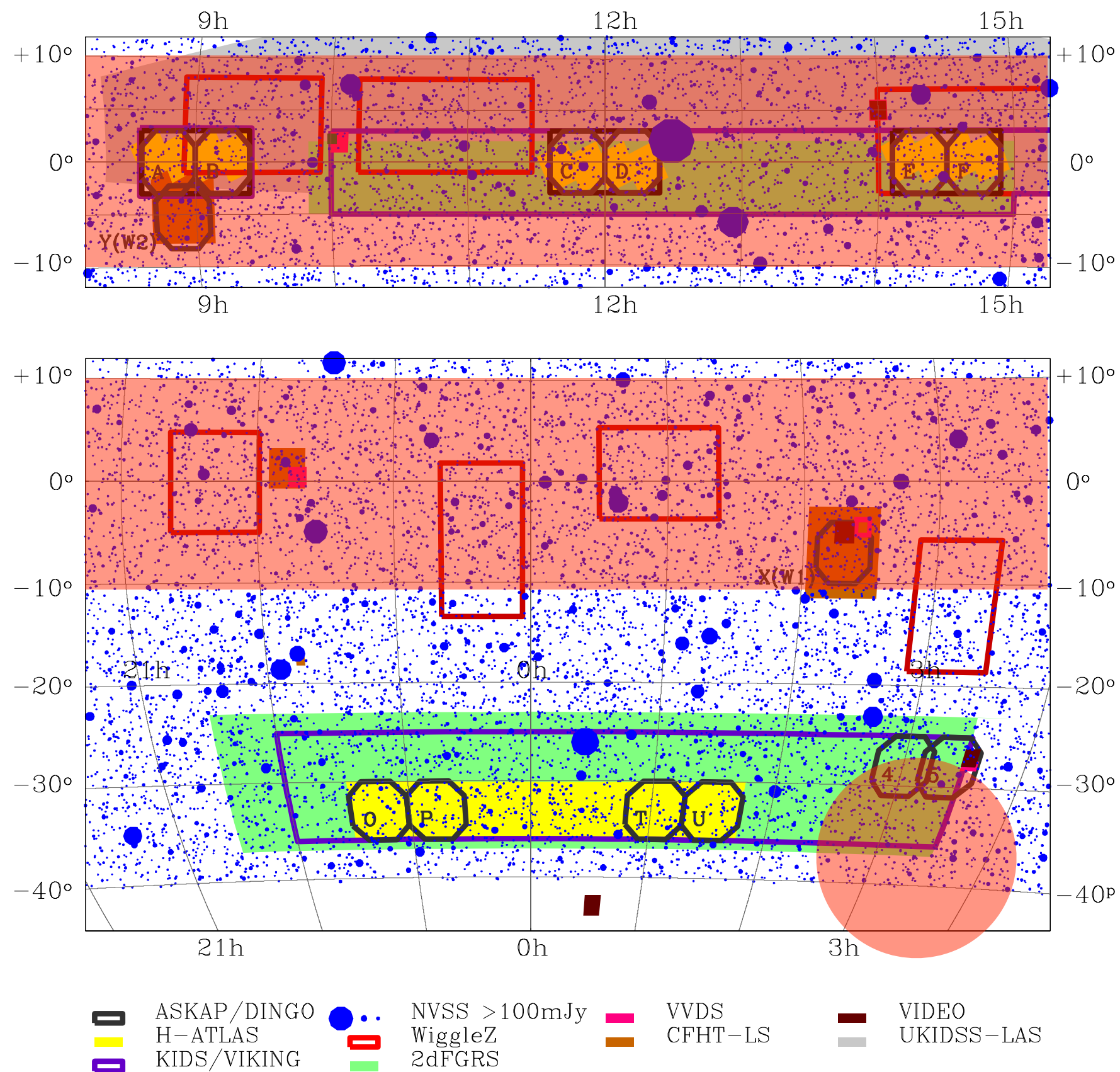




# Where will DINGO look ?

Do commensal science with other surveys

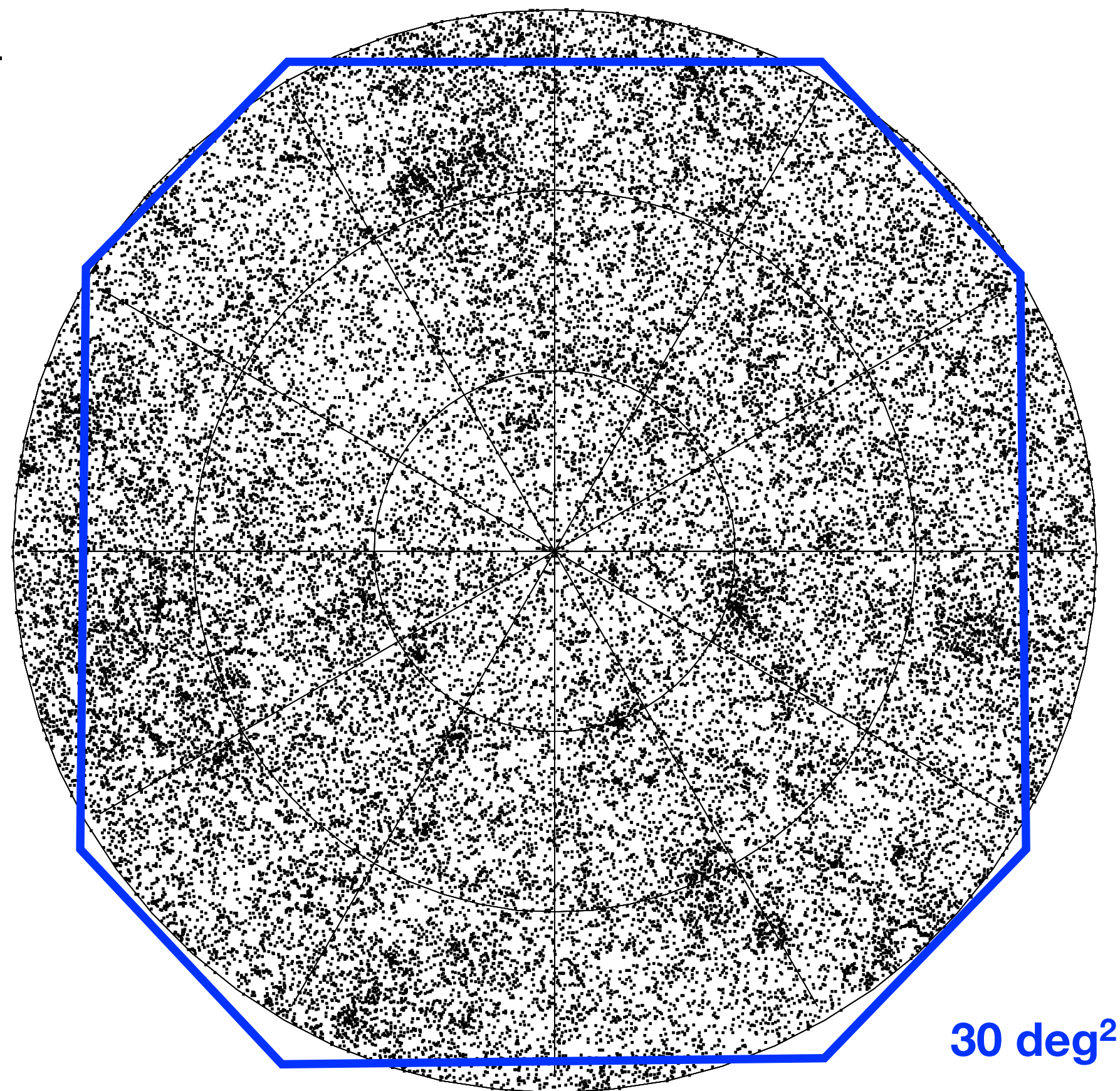
But stay away from the equator and strong continuum sources





# Evolution of $\Omega_{HI}$

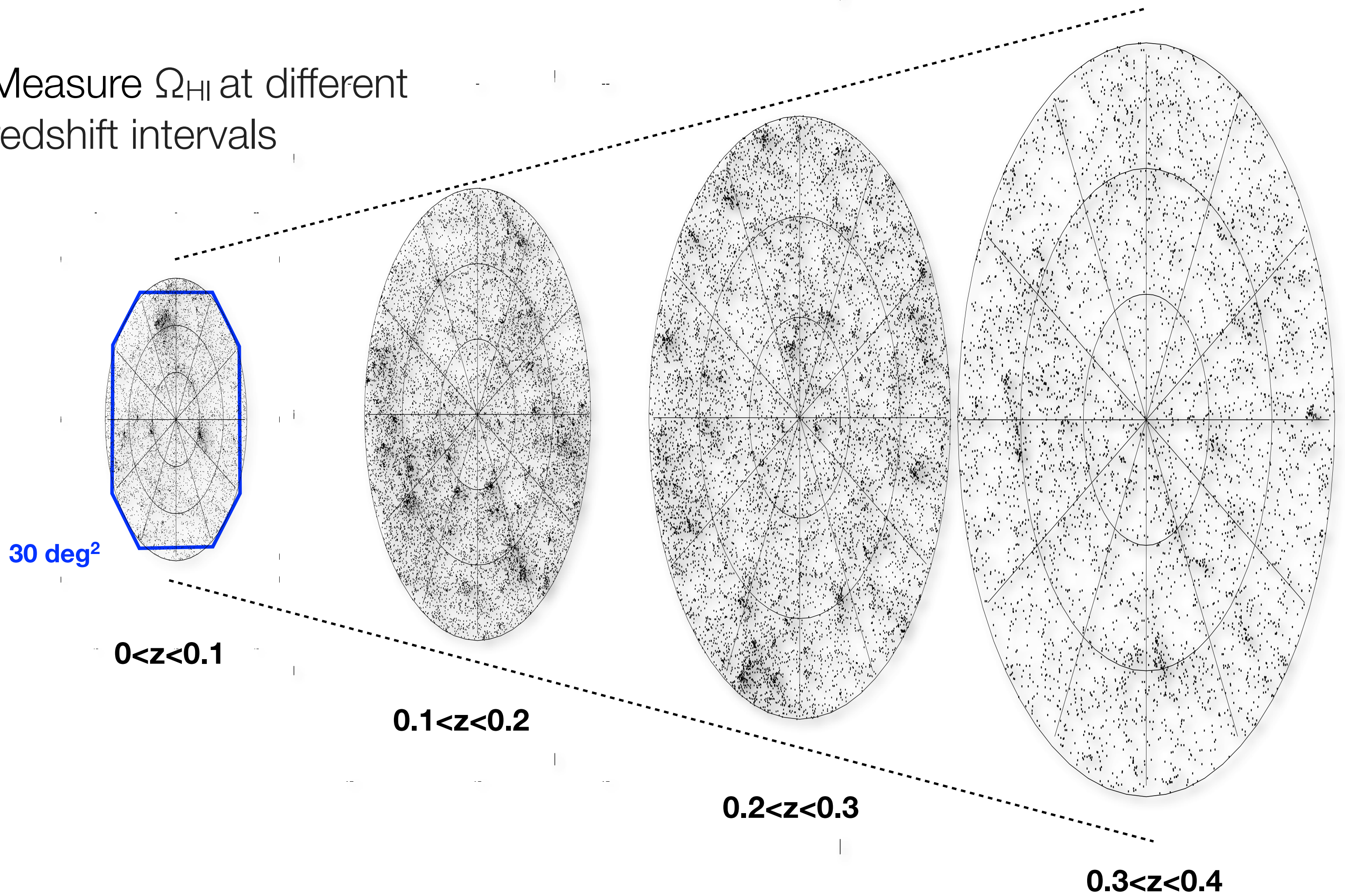
DINGO ultra-deep field



30 deg<sup>2</sup>

# Evolution of $\Omega_{\text{HI}}$

Measure  $\Omega_{\text{HI}}$  at different redshift intervals

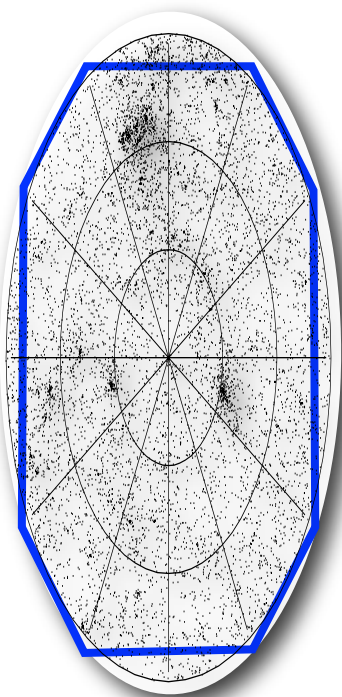




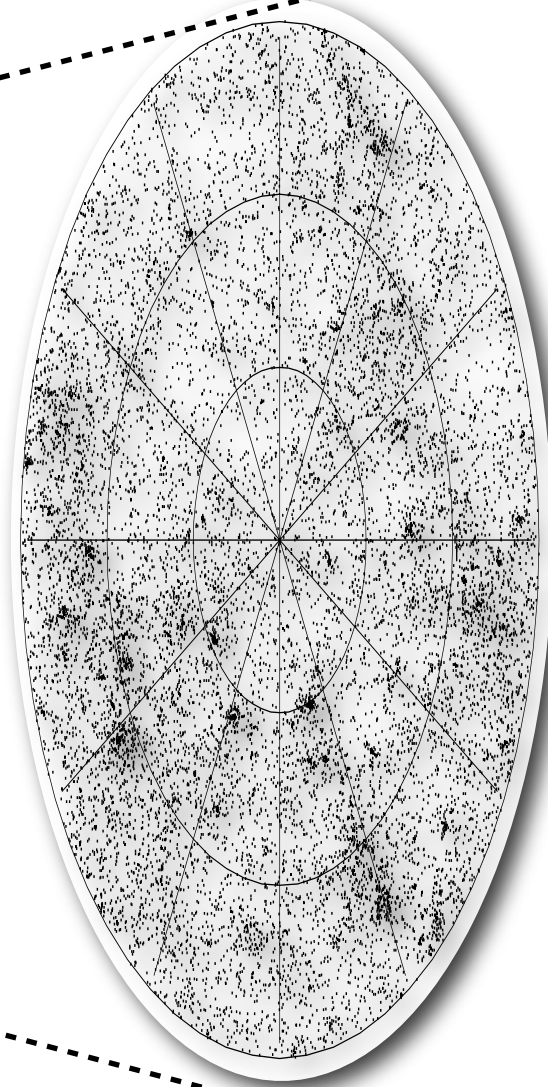
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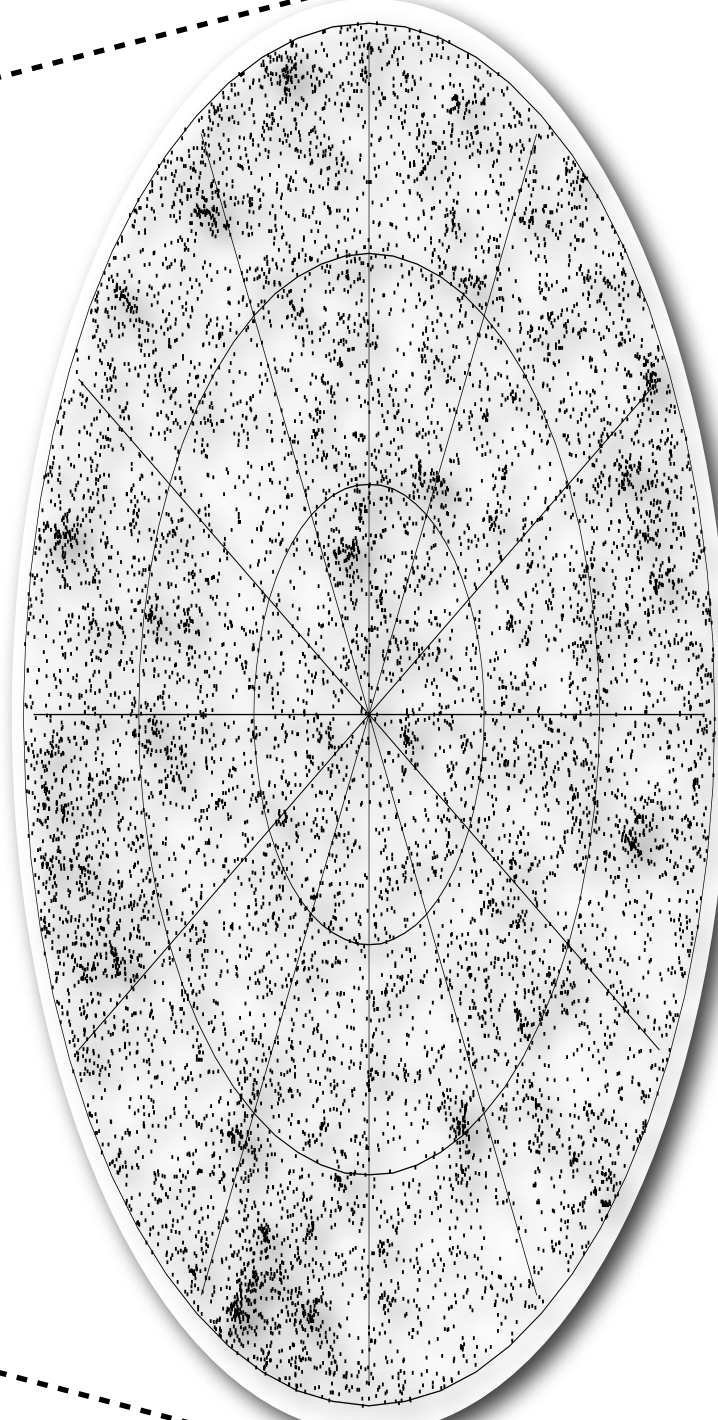
30 deg<sup>2</sup>



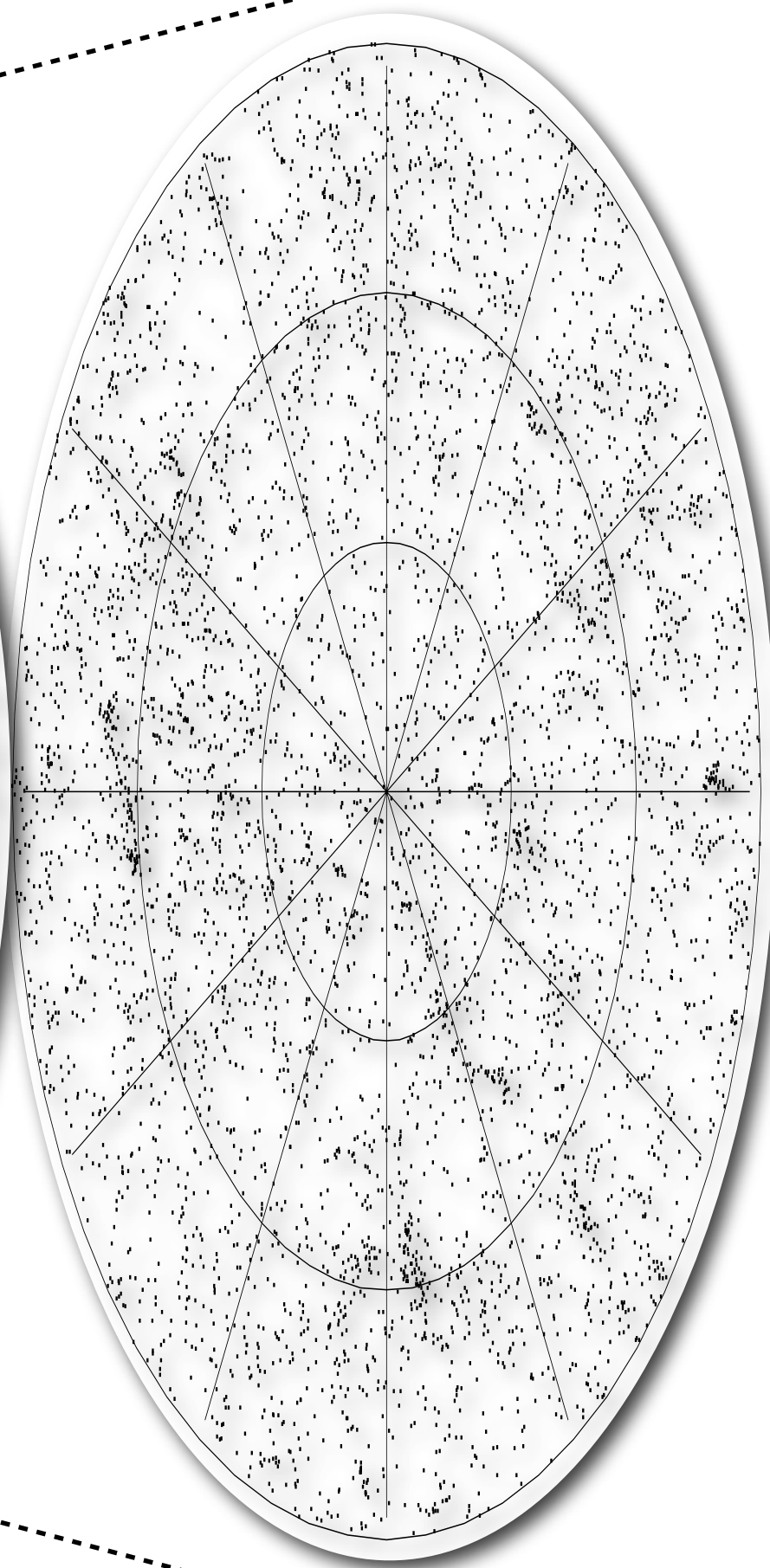
$0 < z < 0.1$



$0.1 < z < 0.2$



$0.2 < z < 0.3$



$0.3 < z < 0.4$

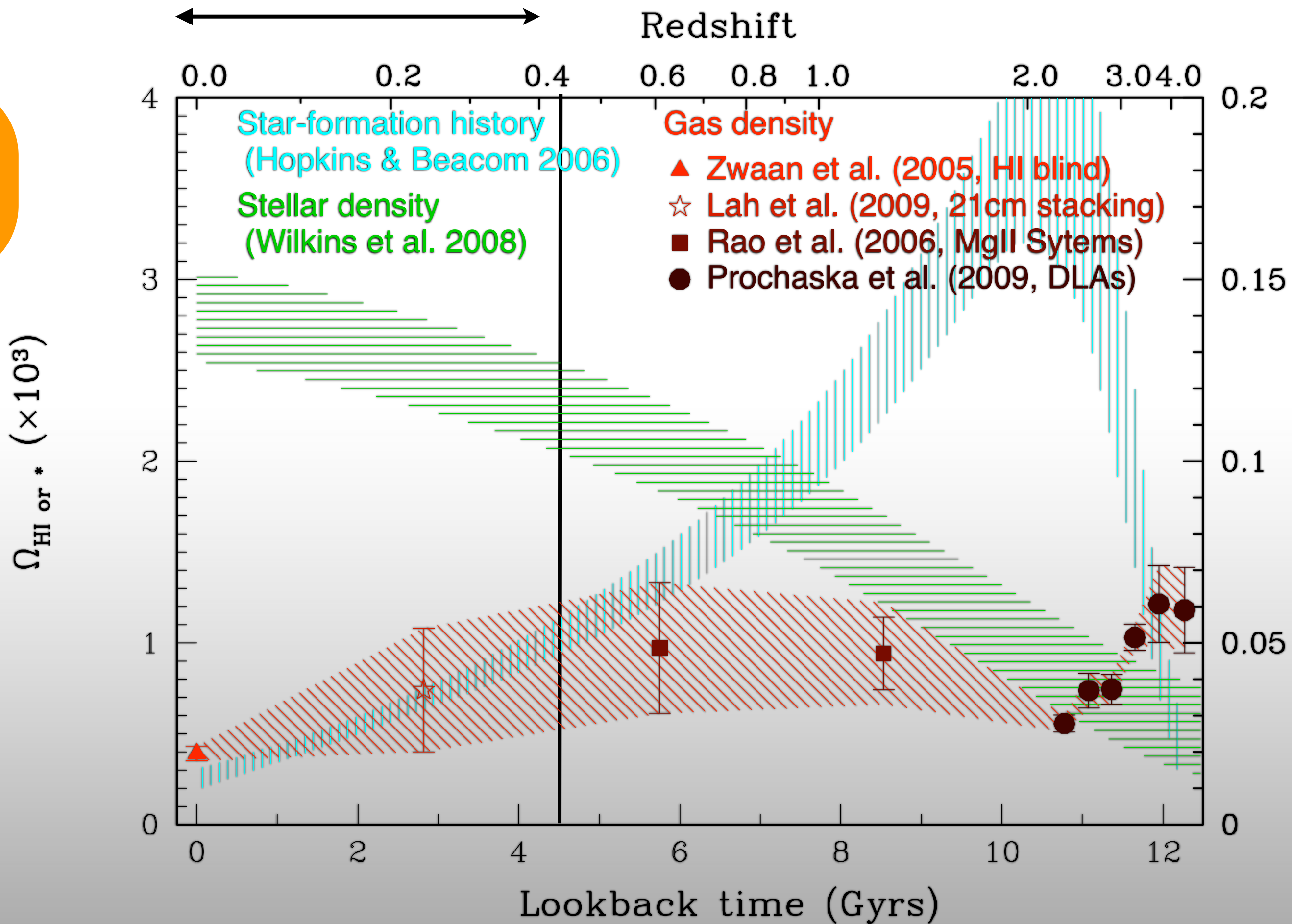


# DINGO science

## Evolution of $\Omega_{\text{HI}}$

- How much HI is there in the Universe? How do we explain  $\Omega_{\text{HI}}$  cf.  $\Omega_{\text{SFR}}$ ?

How has **cosmic mass density** of HI evolved?

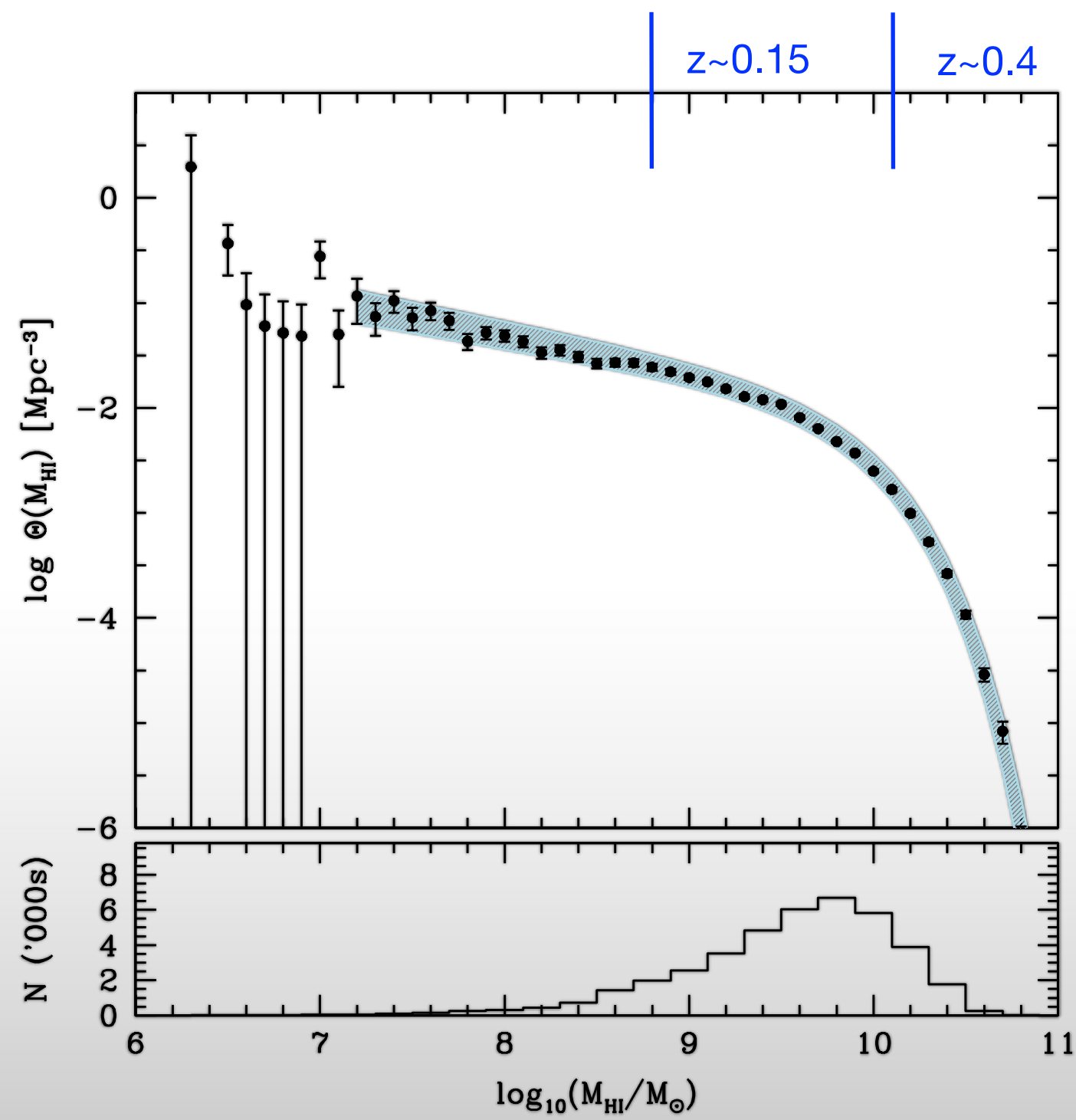






# DINGO science

How has **distribution of HI** in the universe changed with time?

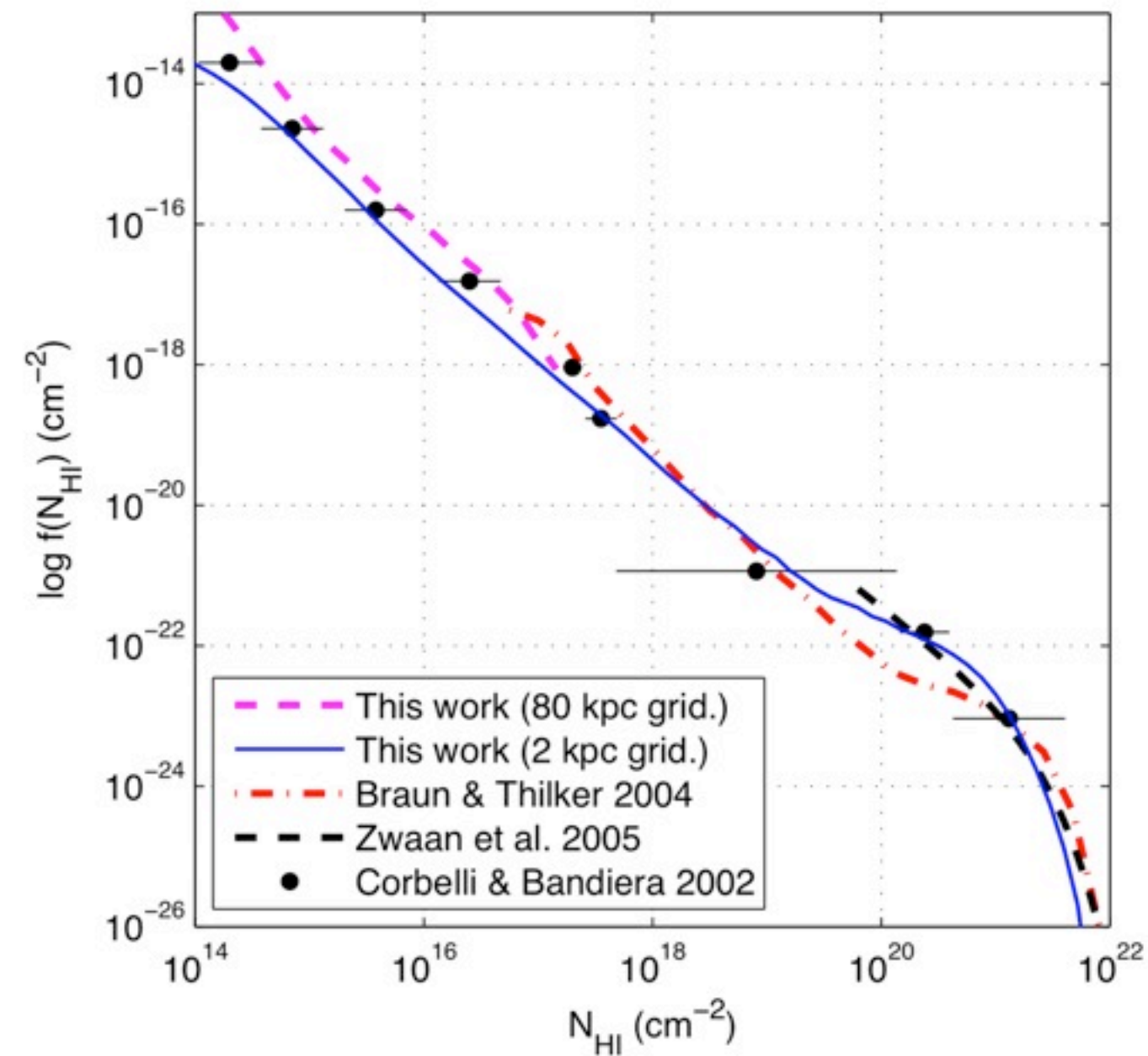
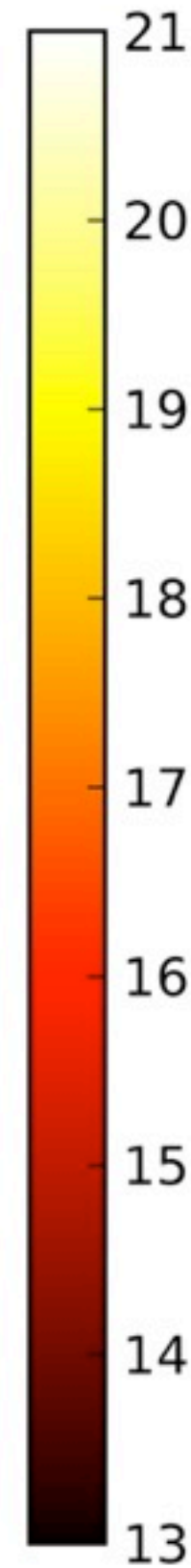
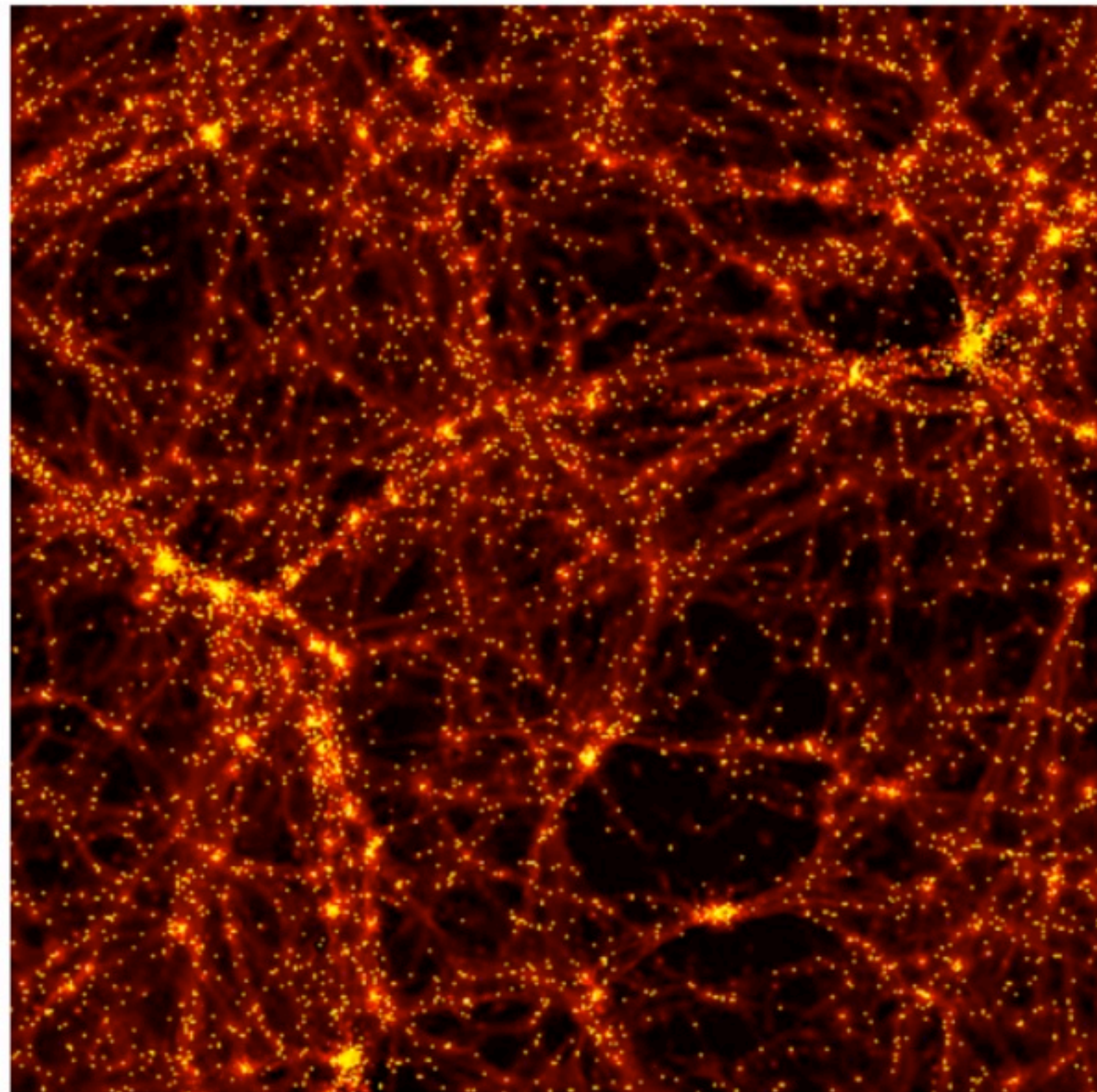






# HI Cosmic Web

$\log(N_{HI})$  Neutral Hydrogen component



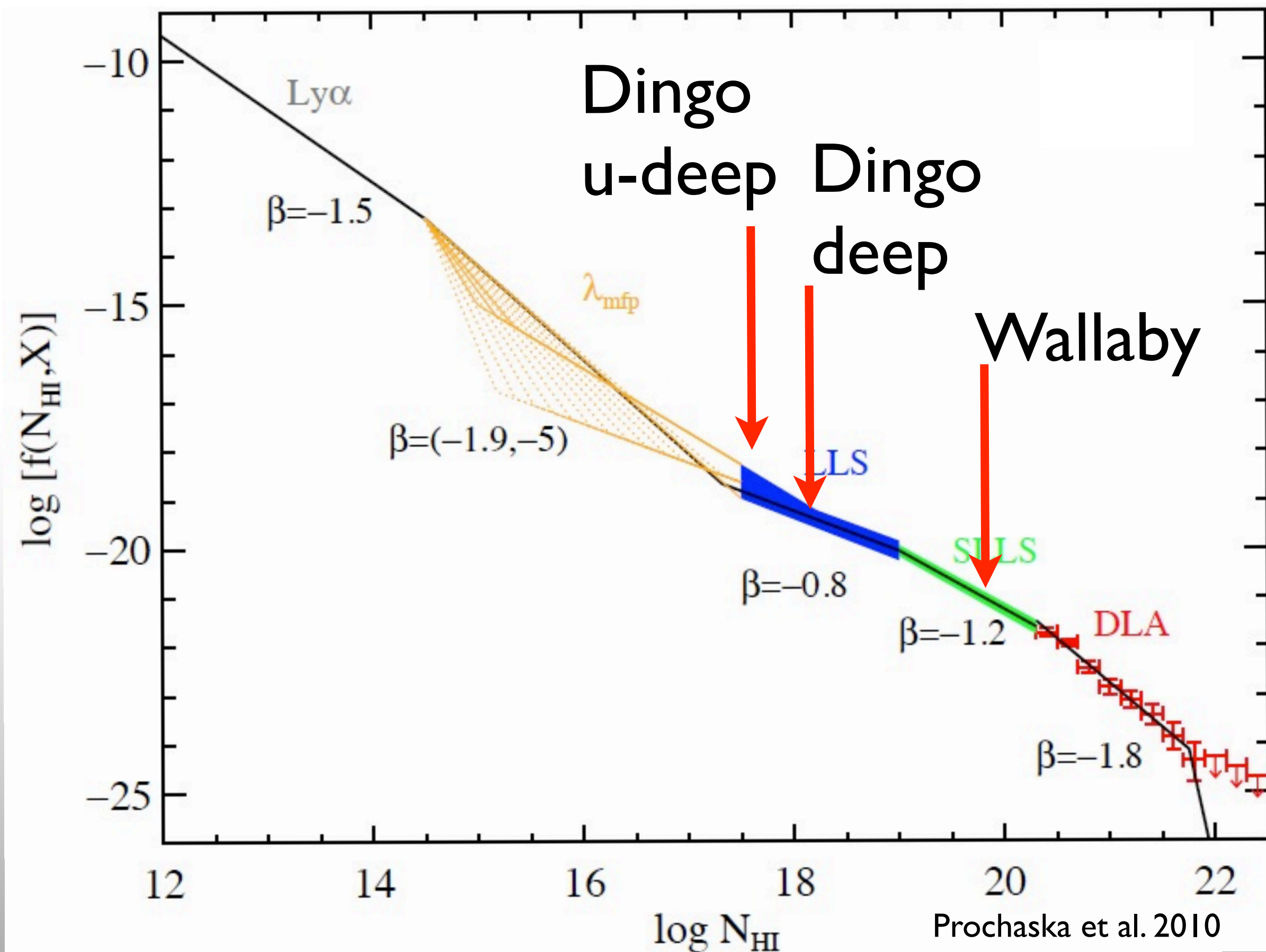
Popping et al. 2009





# HI distribution function

- Get a better feeling for the HI distribution function  $\log(N_{\text{HI}}) < 20$





# Headline Science

How have **gas, dust and stars co-evolved** over the last 4 Gyr?

What drives the evolution of HI content in **groups**?

How has the **star formation efficiency** changed with time?

What kind of dark matter halos do gas-rich galaxies reside in? Is there a **minimum host halo mass**?

How has the **accretion and loss of cool gas** in galaxies changed and what are the dominant processes?

Is HI absent or suppressed within **satellites** orbiting central galaxies?

What is the build-up of stellar and cold-gas mass as a **function of halo mass**?

What is the impact of **environment**?

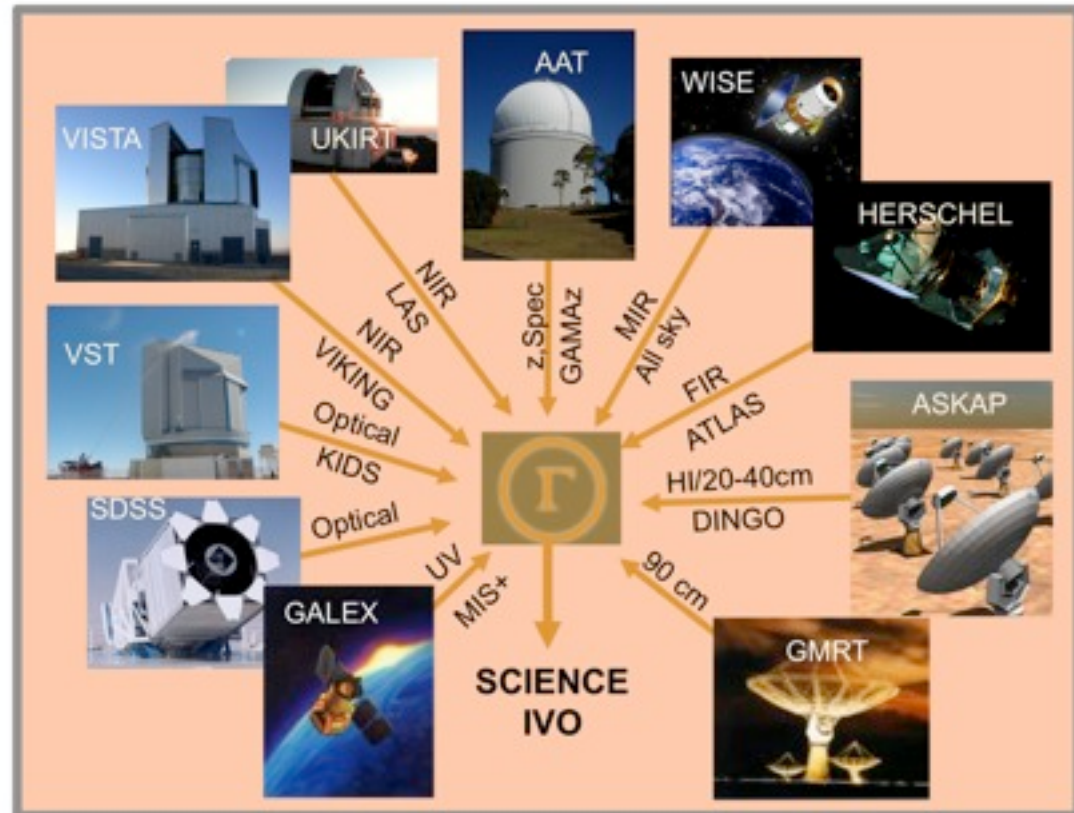
How has **Tully-Fisher** relation evolved  $0 < z < 0.4$ ?







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# Preparation work: e.g. Source Finding

HIPASS : ~ 5000 sources

ALFALFA: ~ 30.000 sources

WALLABY : ~500.000 sources

WNSHS : ~150.000 sources

DINGO : ~ 100.000 sources

APERTIF MDS : ~ 100.000 sources

LADUMA : ~ 10.000 sources

**Reliable automated  
Source Finders  
are needed !!**

**There are several source finders under active development;**

- What is their current state ?**
- Which finders performs best ?**
- Concentrate on completeness and reliability**





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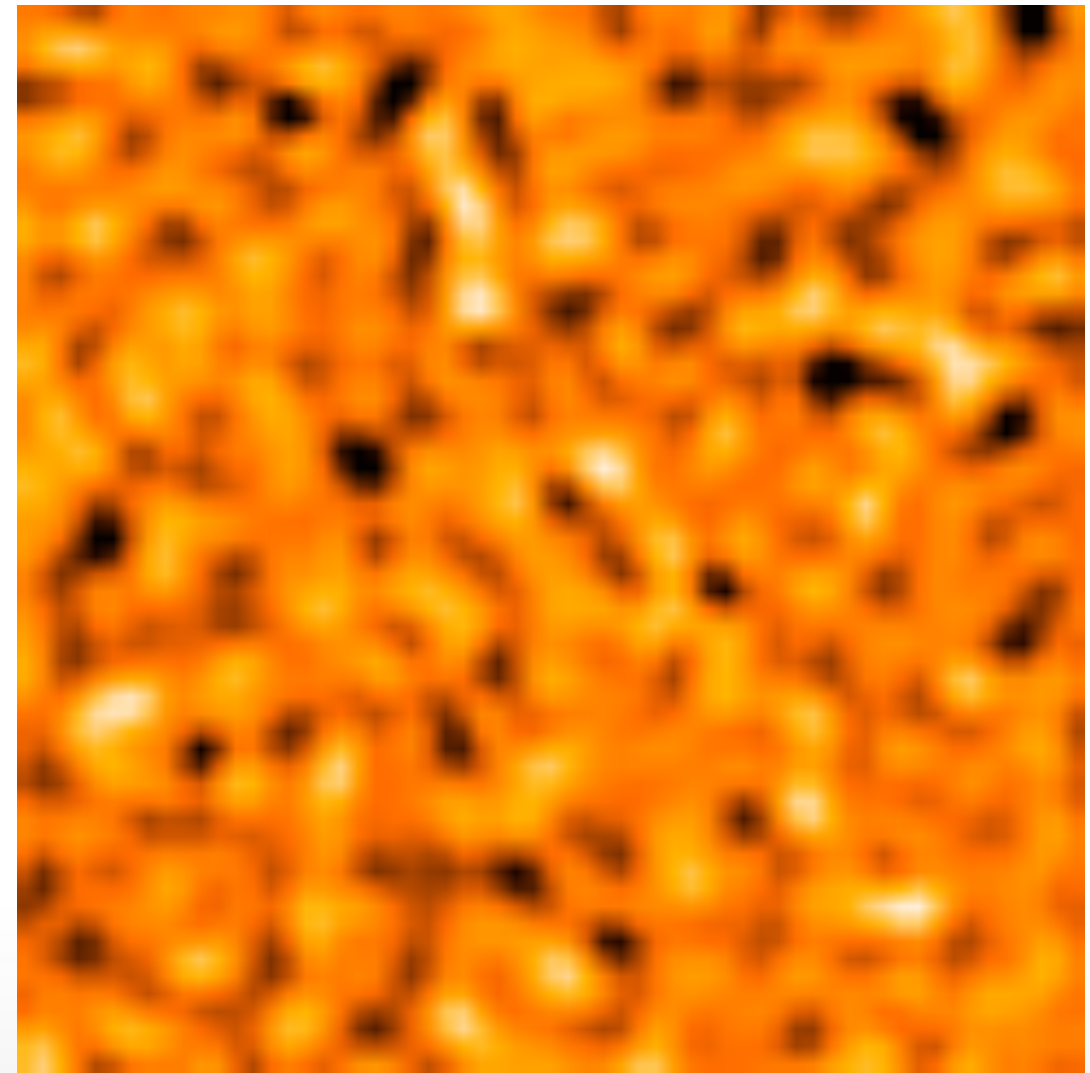
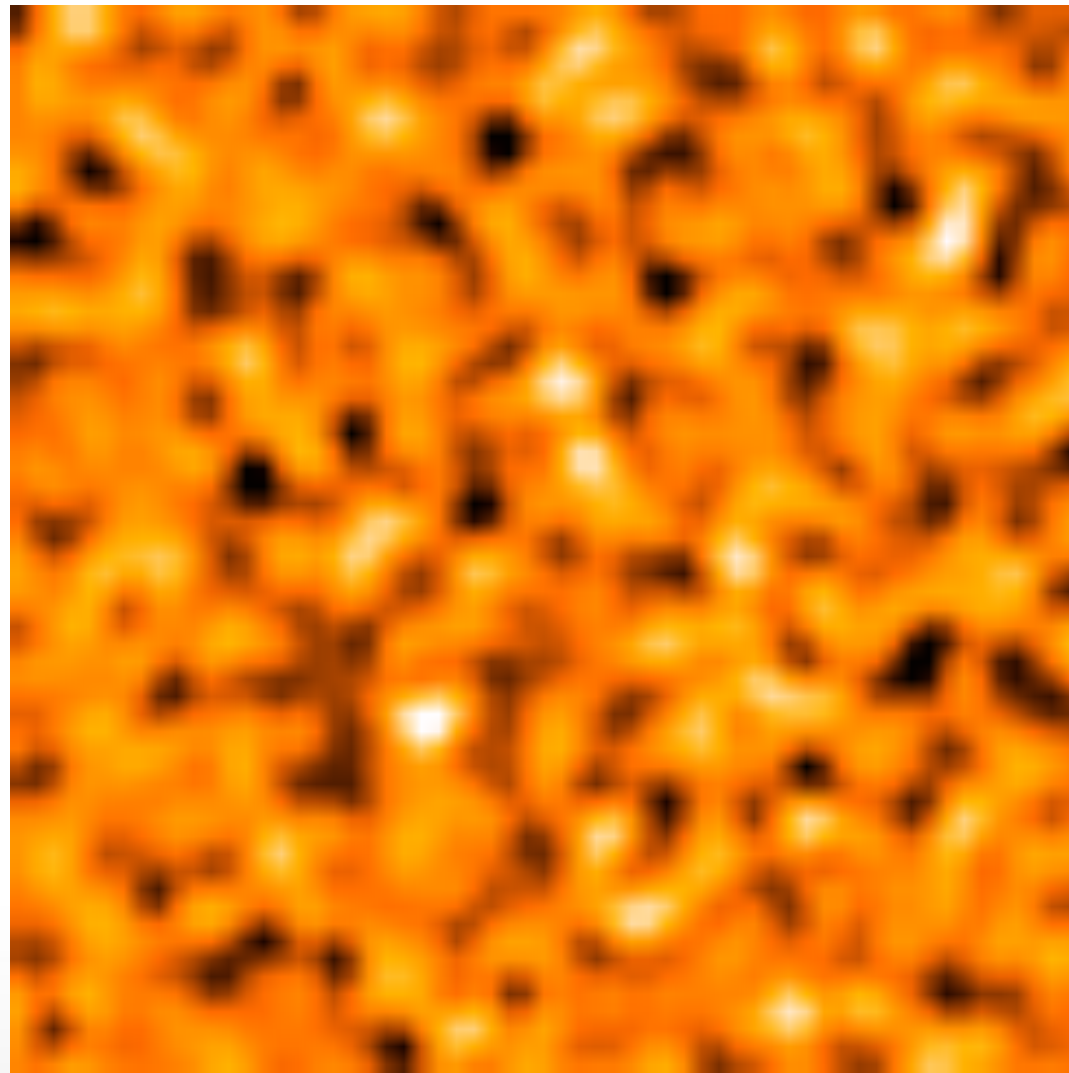
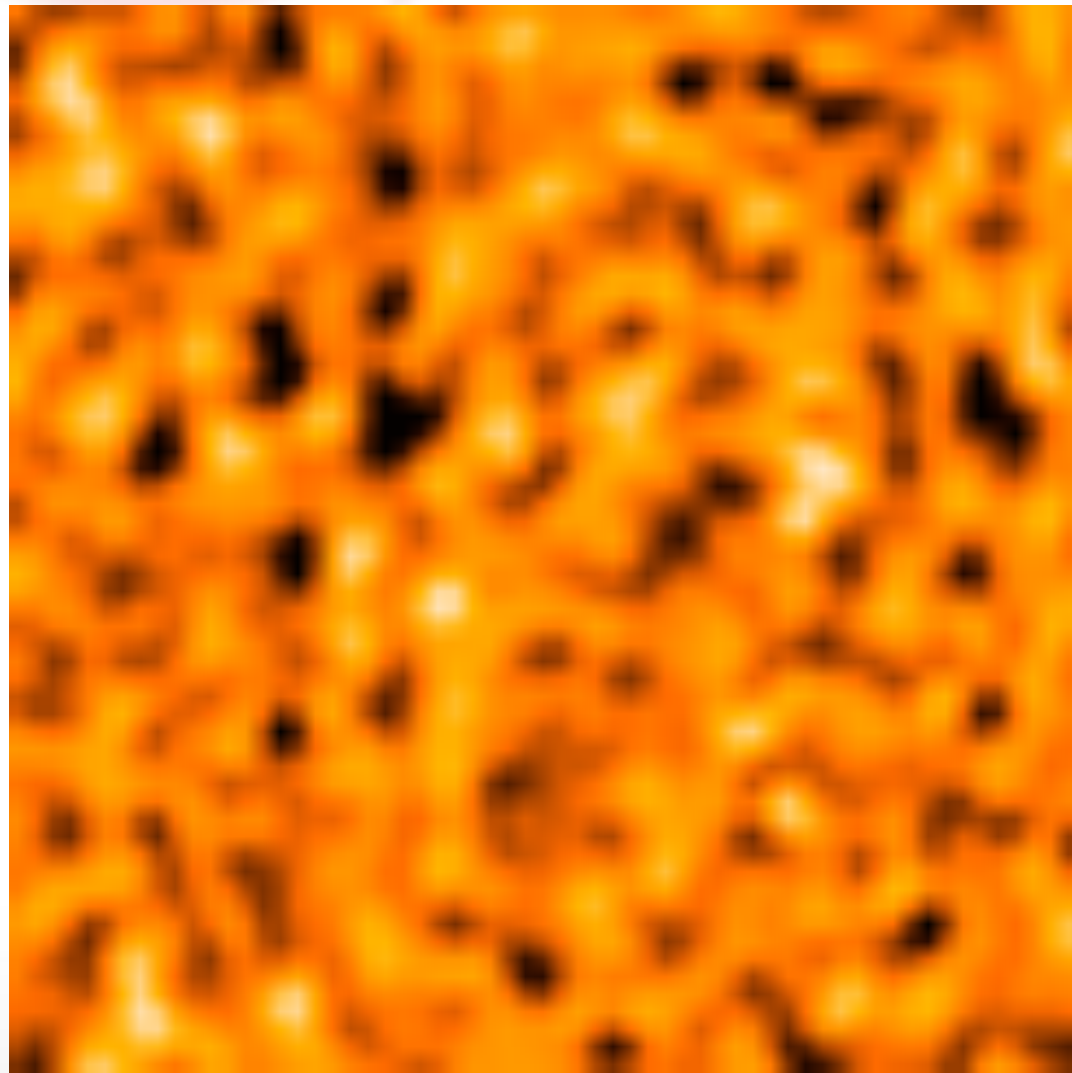
**There are several source finders under active development;**

- **What is their current state ?**
- **Which finders performs best ?**
- **Concentrate on completeness and reliability**

- Source finding cannot be that difficult, right ... ?
- Can you make automated source finders; the human eye is much better



# Fixed integrated Signal to Noise

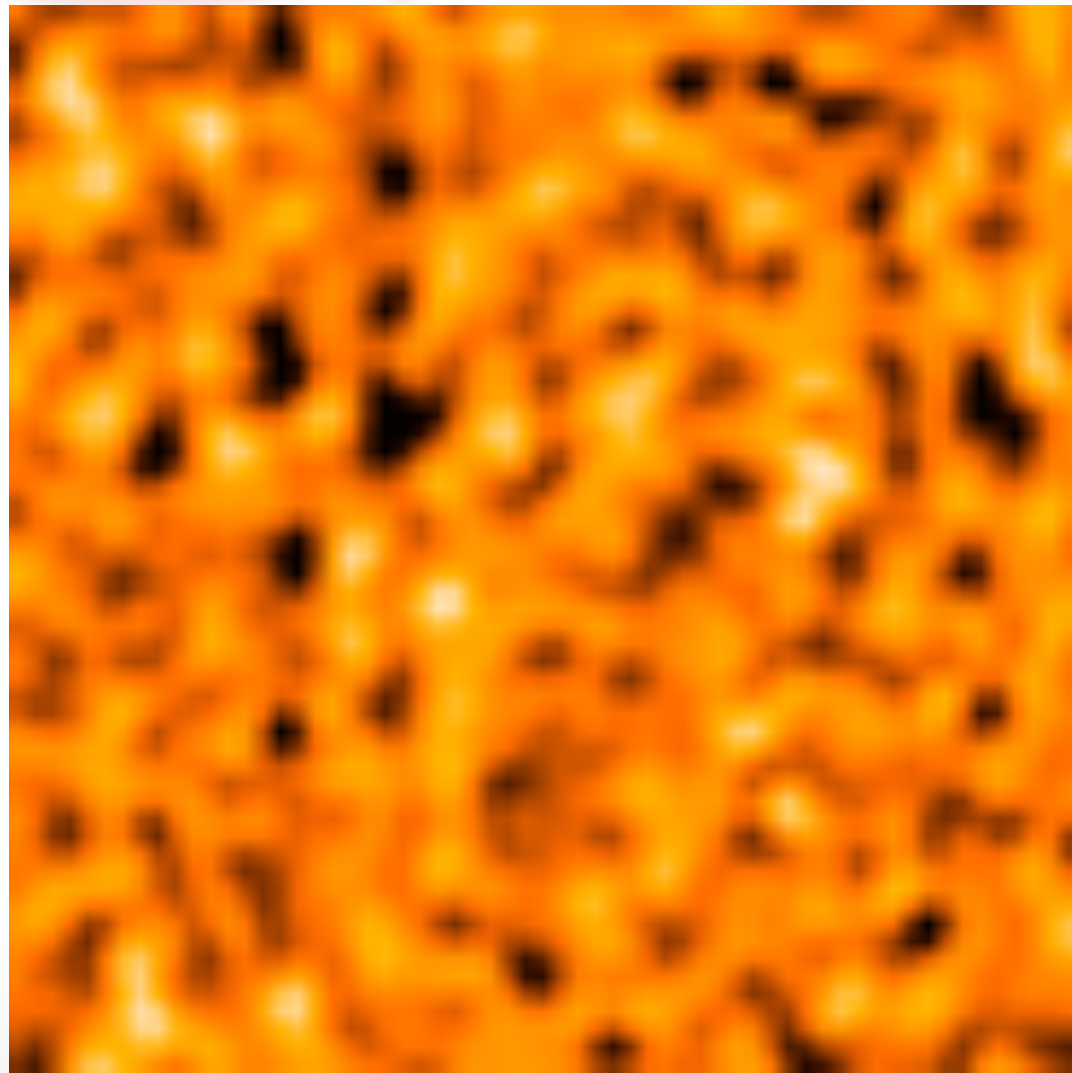


S/N: 1, 3, 5, 10, 20, 50, 100 ??

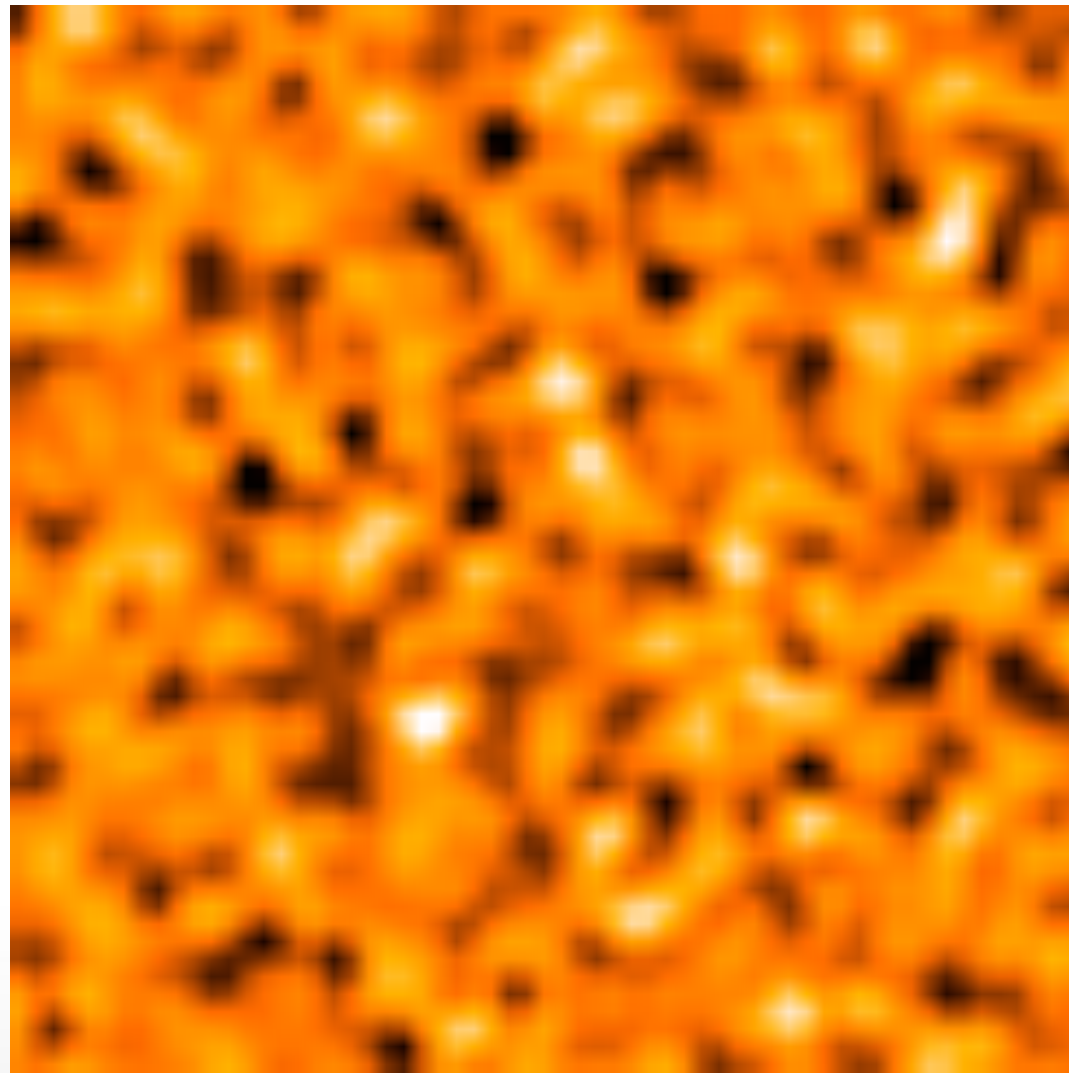




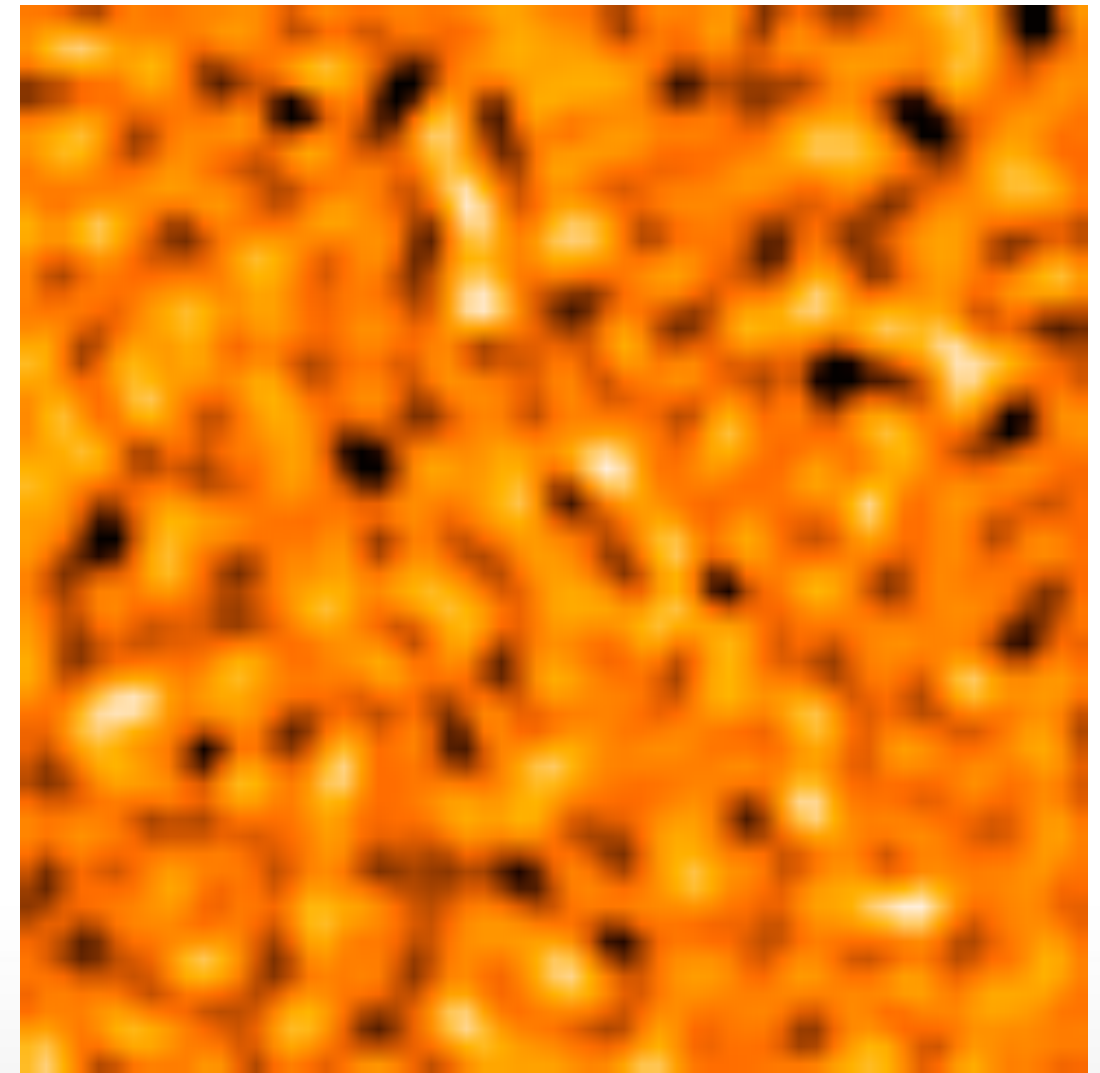
# Fixed integrated Signal to Noise



10



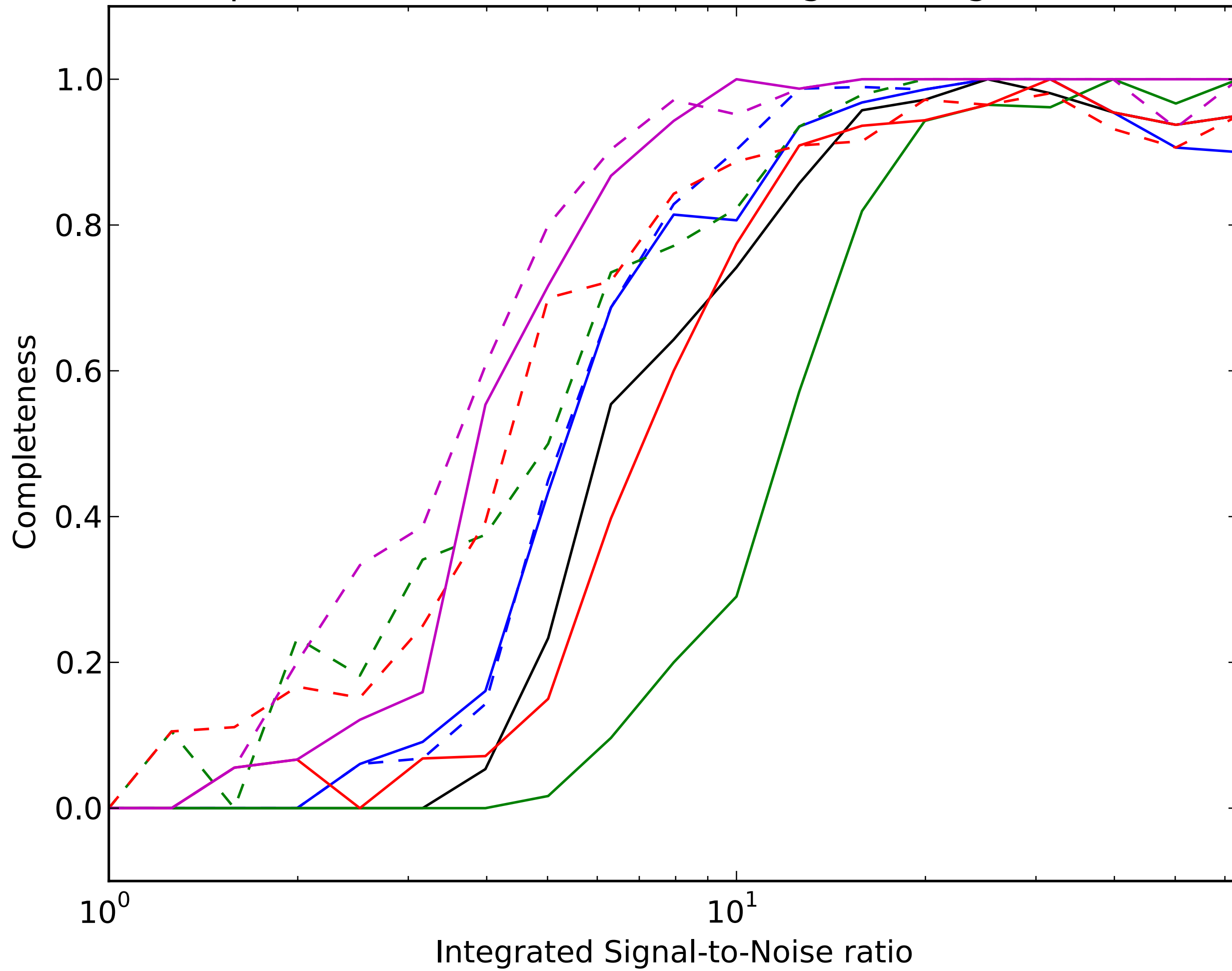
50



100



# Completeness Model Galaxies - Integrated Signal to Noise



Popping et al. 2012





# We need more help using outreach



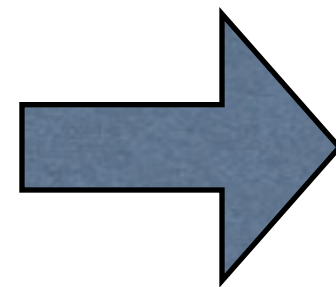
People don't always know what you are doing



# We need more help using outreach



People don't always know what you are doing



You want them involved, and you want them to like you






# theSkyNet.org

theSkyNet - Running...

www.thesky.net.org/run?userid=100134



## theSkyNet

**You are now contributing to theSkyNet.**

Once this window is closed, your contribution will end.

To contribute to the skynet without needing this window open, why not **download the background application?**

Show your client

Transferring data from www.go...

theSkyNet

www.thesky.net.org/account/index?state=fromLogin


Home About Resources Contact

## theSkyNet

### Account Dashboard

Dashboard Trophies Alliances Announcements Ladders FAQ Forums Manage Account

Monday 23rd January, 2012 - [Forum log in issues](#): Edit 25/01/2012: Issues are all fixed now. Let us know if you notice anything else going on! There's been something weird going on which has meant that the 'Single Sign On' to the forum hasn't been working, so no one ... [Continue reading](#)



**You are now contributing to theSkyNet.**

[Click here](#) to pause your contribution.

Why not tell your friends on facebook and build an alliance?

#### Your Contribution Status:

Connections (Last 10 Mins): 1 (100 MIPS)

You are 390 credits away from your next trophy.

3380  4000

Welcome back, Attila

Click 'Start' above or, [download the automatic software.](#)

TOTAL CREDITS EARNED:

# 3610

[\(What are credits?\)](#)

Monthly Downloads: 0.00 MB    Current Limit: **Not set**

theSkyNet Account ID: 100134    Current Ranking: 1478

#### Ladders

Last updated 27 Jan 9:19:01.

Individual    Alliances

#1 <a href="#">vk5fj</a>	↑ 550912 credits
#2 <a href="#">MattS1984</a>	↑ 534050 credits
#3 <a href="#">jamestiling</a>	↑ 360925 credits
#4 <a href="#">oxfordphysics</a>	↑ 353819 credits



# Datasets:

- HIPASS
- ASKAP simulation
- DINGO simulation

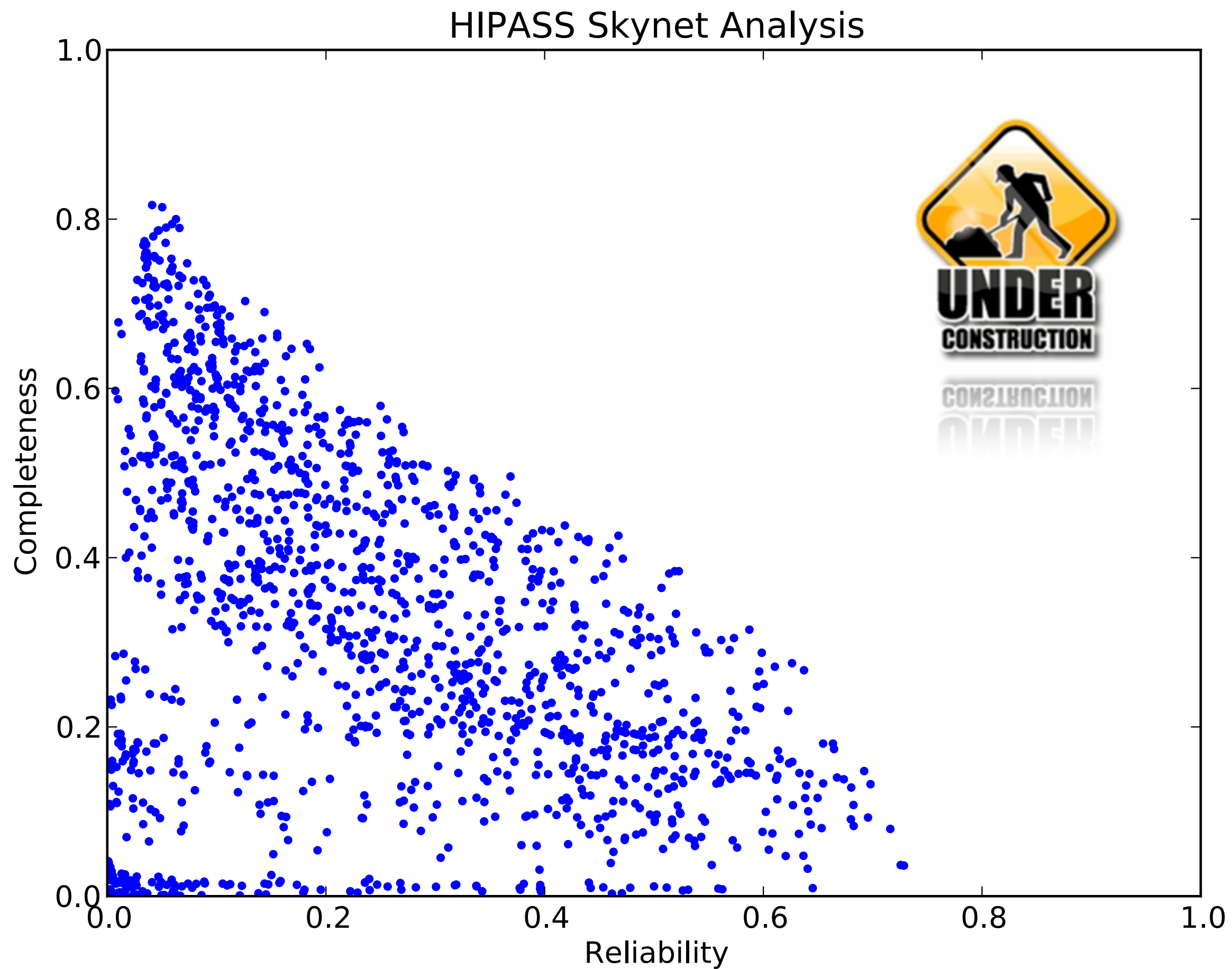
Each dataset is about 65 Gb in size, impossible to do on your own machine

- Very powerful tool; full HIPASS takes a few minutes to process
- Ideal to test many many parameters
- Currently only running Duchamp, but there are plans to implement other source finders



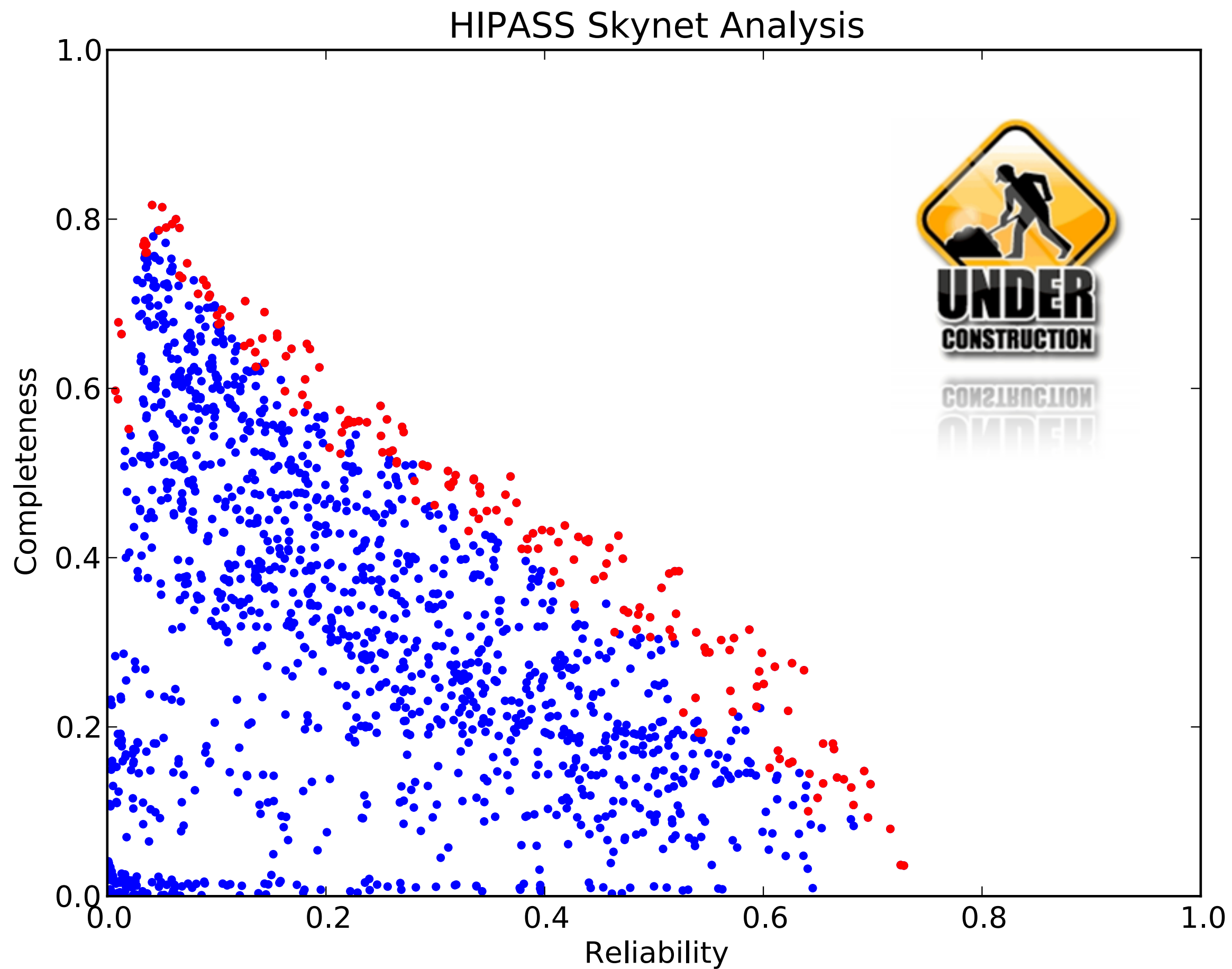


# Show here HIPASS result with skynet





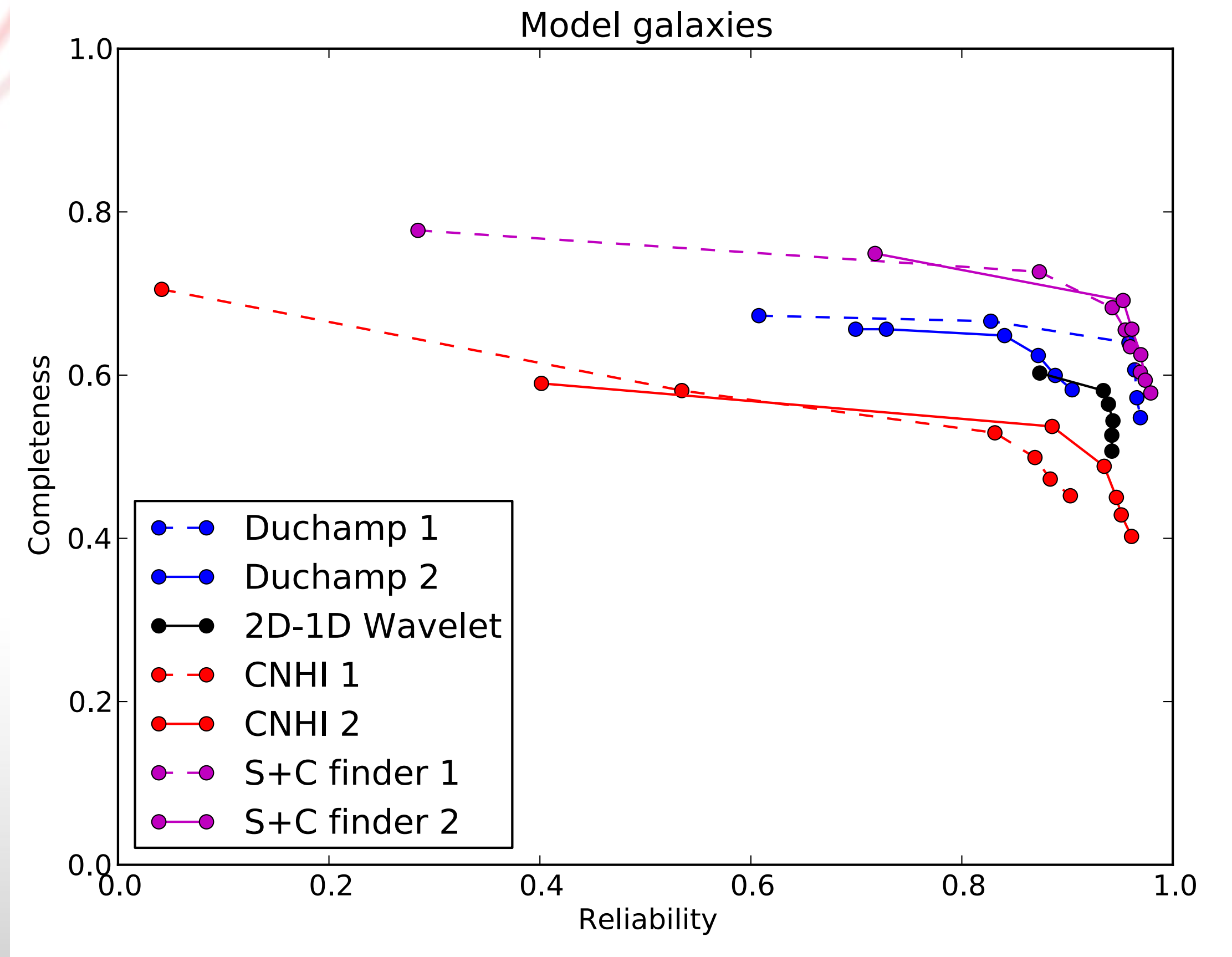
# Show here HIPASS result with skynet







# Completeness vs Reliability



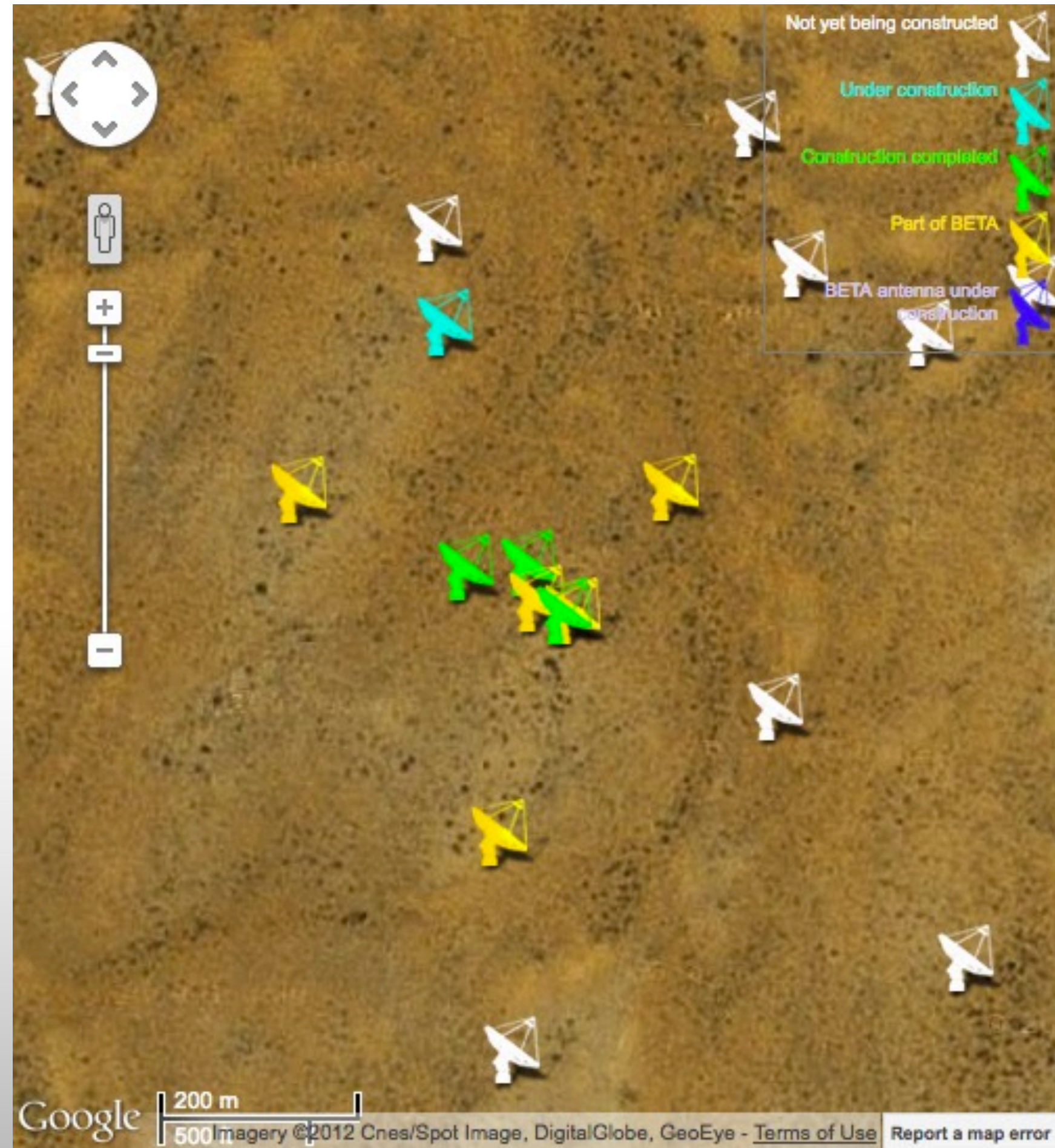
Reliability improves significantly after applying a cut on detections in integrated flux





# Boolardy Engineering Test Array

**BETA:**  
First 6 complete ASKAP dishes







# Field of View



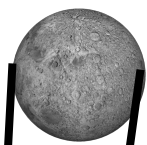
FOV  $\sim 0.25$  deg<sup>2</sup>



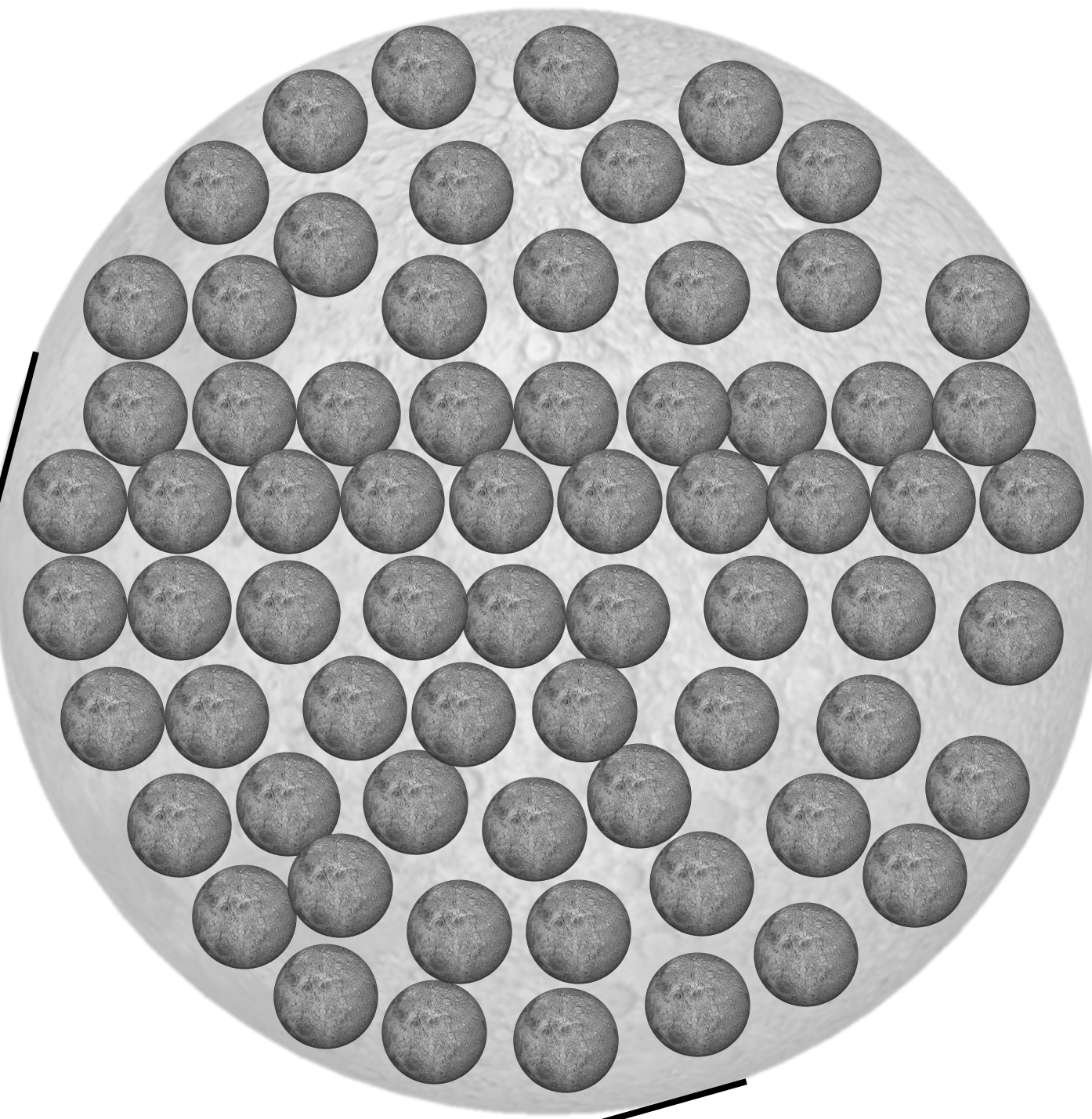
ATCA



# Field of View



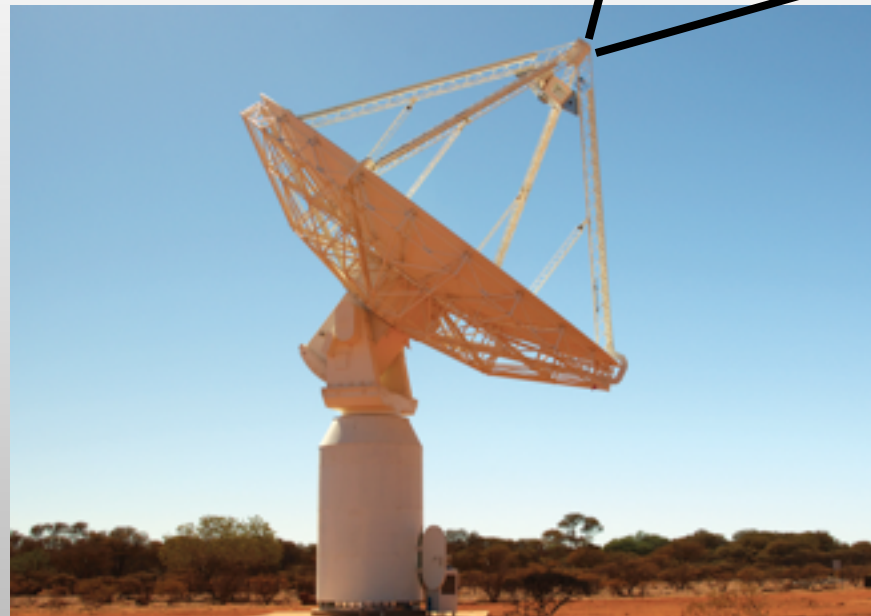
FOV  $\sim 0.25$  deg<sup>2</sup>



FOV  $\sim 30$  deg<sup>2</sup>



ATCA



ASKAP

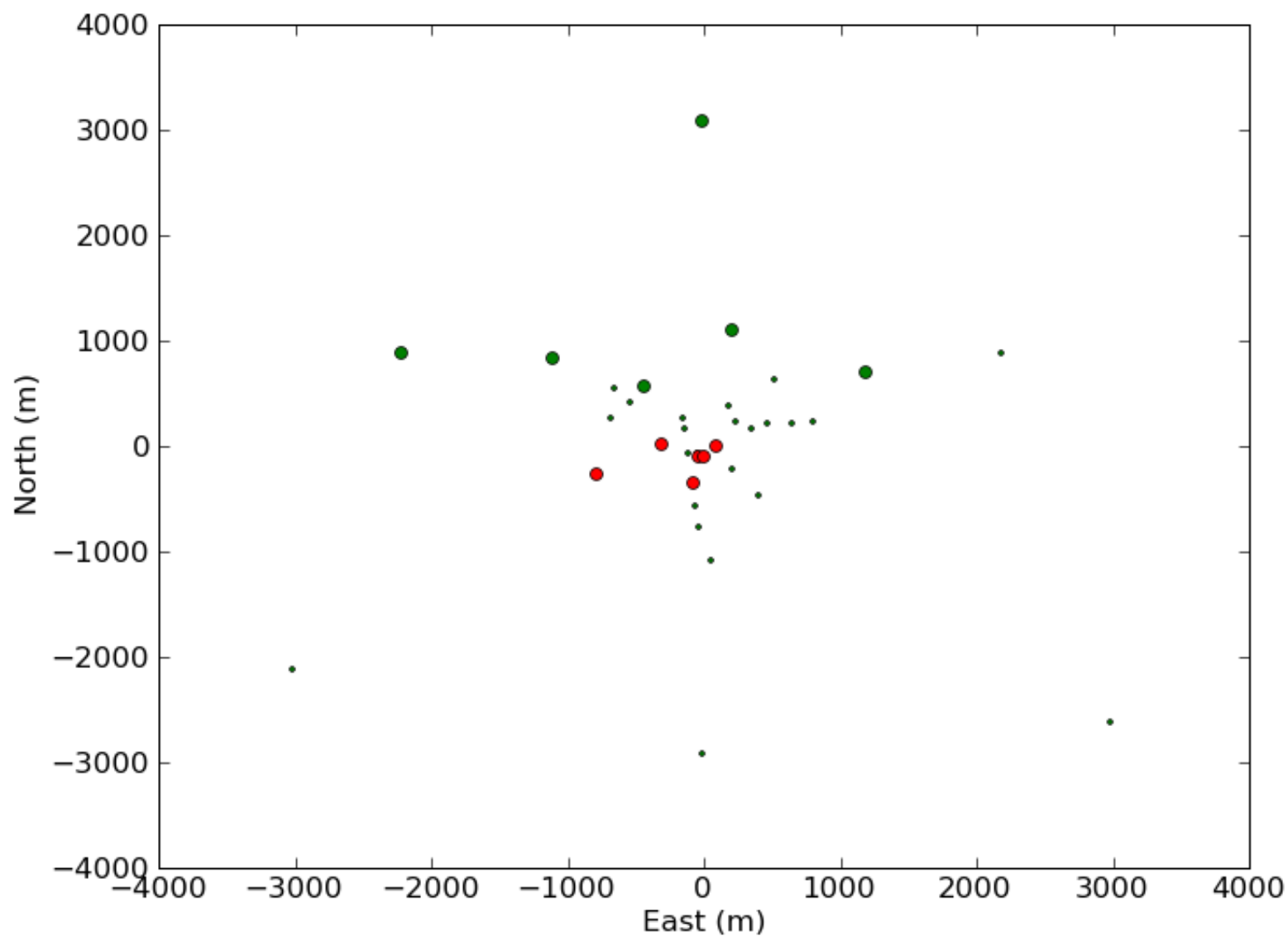
factor  $\sim 120$  gain !!





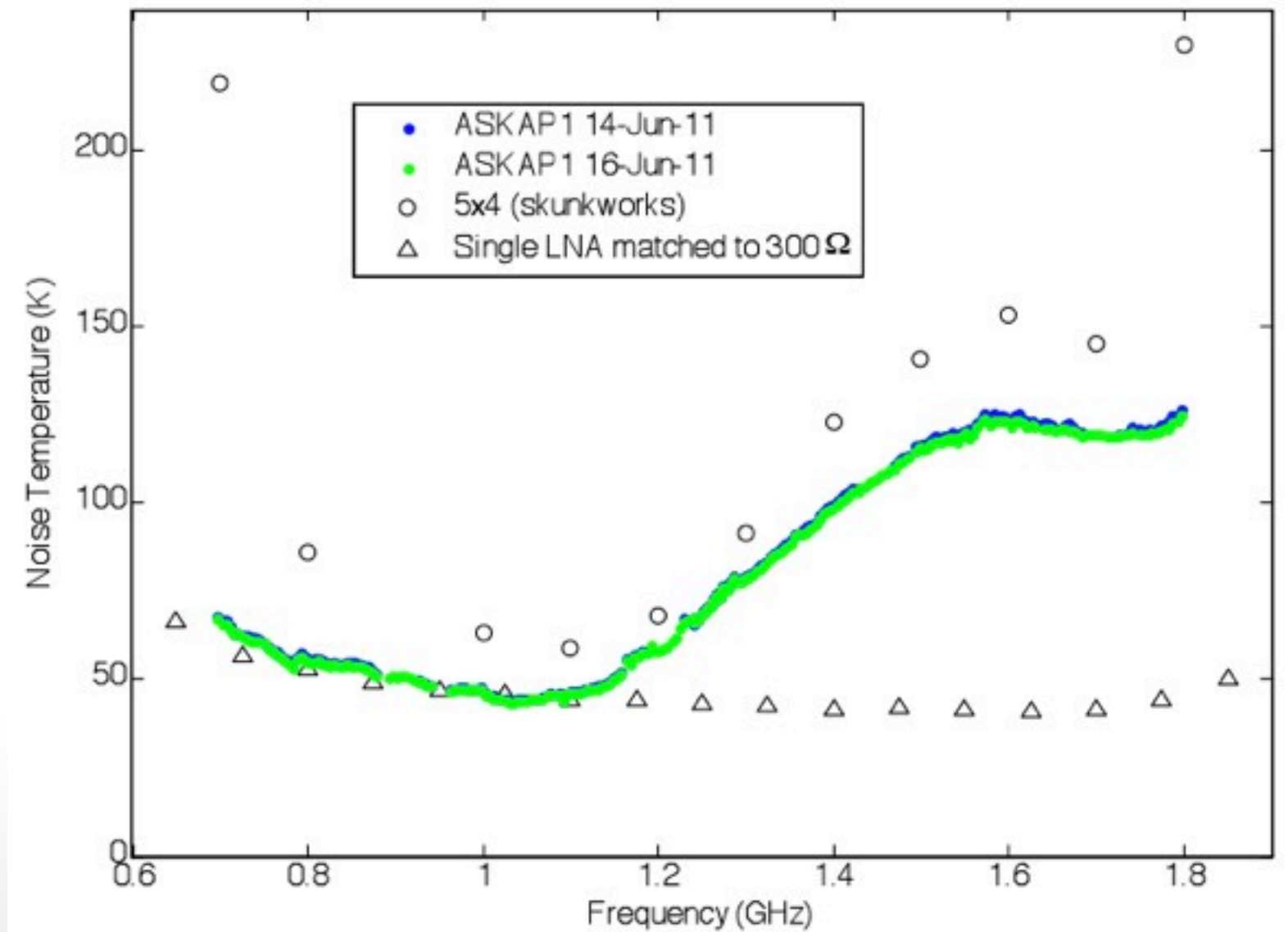
# BETA & ASKAP-12

ASKAP - 12



T<sub>sys</sub> 1<sup>st</sup> PAF

Approximate Beamformed Aperture Array Receiver Temperature  $T_{rx} \approx 295/(y-1)$   
Not Corrected for Sky Brightness  
Beamformed on Radiated Noise at Boresight



ASKAP : 2014 +  
ASKAP-12 : 2013  
BETA : 2012

**What can we do with BETA and ASKAP-12 ... ?**



# Crucial phase of first DINGO baby steps



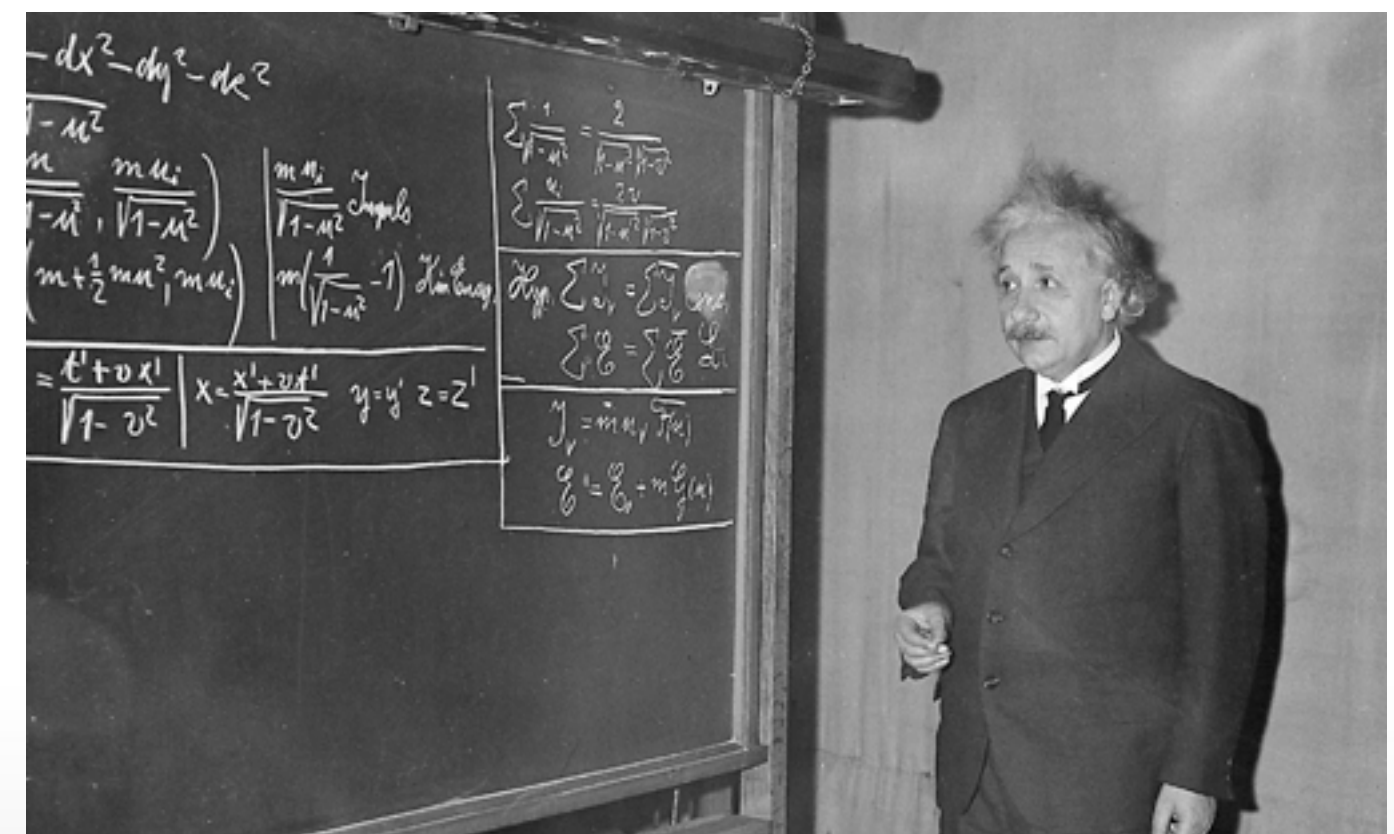


# Crucial phase of first DINGO baby steps





# Crucial phase of first DINGO baby steps







# Crucial phase of first DINGO baby steps





# DINGO stacking experiment



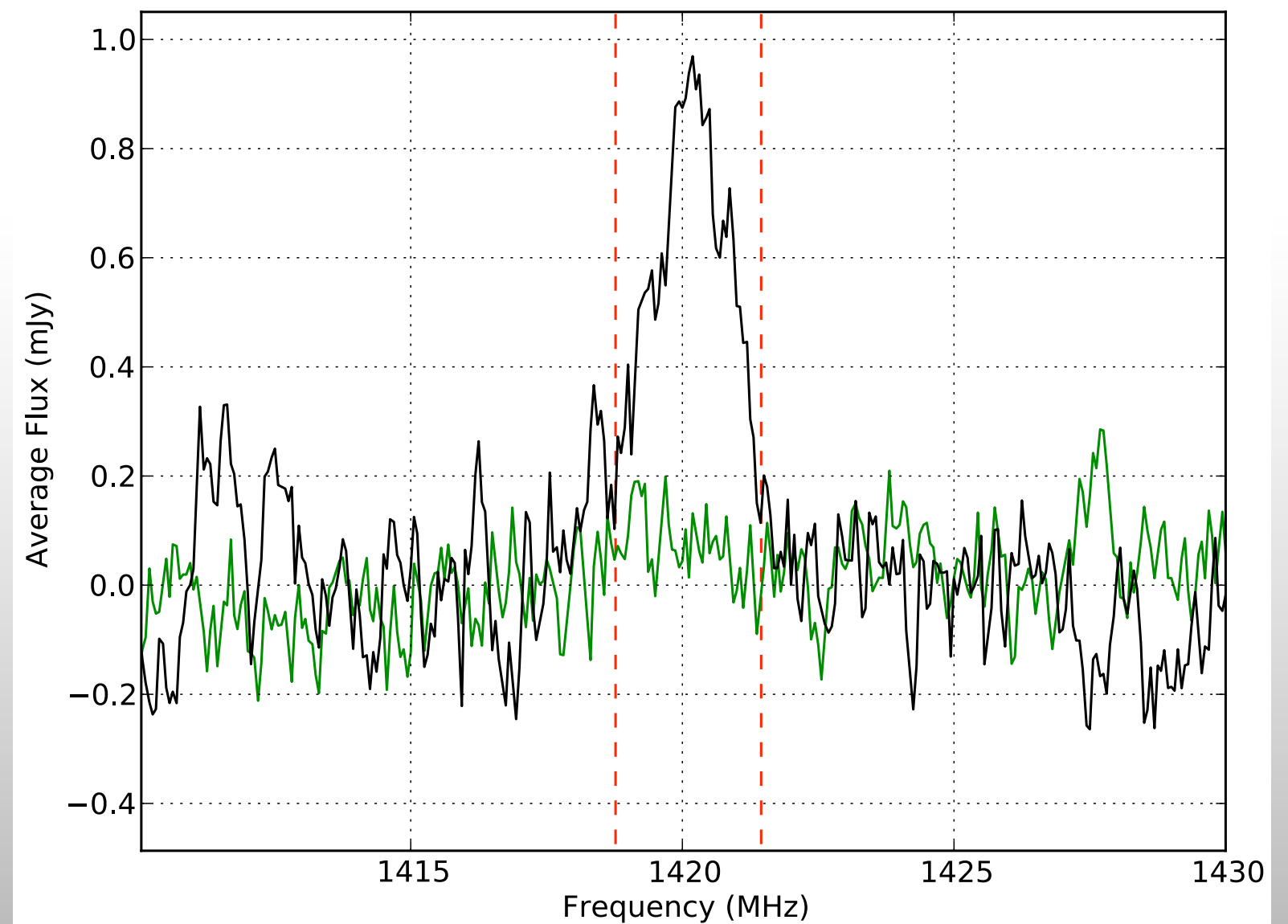




# DINGO stacking experiment

Extracting a statistical HI signal by co-adding the **21-cm line emission** from multiple galaxies using their **known positions and redshifts**

**DINGO: HI to  $z \sim 0.4$**   
**GAMA: optical spectra**



J. Delhaize

DINGO



# GAMA 9hr field, 30 deg<sup>2</sup> (ASKAP FOV)

Bandwidth [MHz]	z-range	nr sources	max baseline [meter]
1000 - 1100	0.42 - 0.29	5500	1950
1100 - 1200	0.29 - 0.18	9500	1780
1200 - 1300	0.18 - 0.093	5500	1650
1300 - 1400	0.093 - 0.014	2200	900

Baselines of ASKAP-12 should be no longer than 2km





# BETA, 100 hours integration time

Bandwidth [MHz]	Fint (M*) [mJy km/s]	T <sub>sys</sub>	$\sigma$ (1 MHz) [mJy]	S/N (200 km/s)	S/N stack
1000 - 1100	24	50	3.56	0.23	18
1100 - 1200	43	50	3.56	0.43	42
1200 - 1300	100	70	5.0	0.71	52
1300 - 1400	560	100	7.1	2.8	131



# ASKAP-12, 100 hours integration time

Bandwidth [MHz]	Fint (M*) [mJy km/s]	T <sub>sys</sub>	$\sigma$ (1 MHz) [mJy]	S/N (200 km/s)	S/N stack
1000 - 1100	24	50	1.8	0.47	35
1100 - 1200	43	50	1.8	0.84	82
1200 - 1300	100	70	2.1	1.68	125
1300 - 1400	560	100	2.7	7.33	344





**BEWARE OF THE**  
**DINGO**