CHILES

CHILES, the COSMOS HI Large Extragalactic Survey

1002 hours JVLA B array

SKA Science   and a path finder for the path finders

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(the pilot..ApJ Letters, 2013, Fernandez et al) ..plus..

Lucas Hunt, John Hibbard, Min Yun, Rien van de Weygaert, Joe Lazio, Aeree Chung, Martin Meyer, Andreas Wicenec, Ryan Joung, Amidou Sorgho, Claude Carignan, Danielle Lucero, Natasha Maddox, Genevieve Vaive, Charee Peters

USA, South Africa, Germany, Australia, The Netherlands, Korea

Unique aspects of VLA among SKA path finders

- Strengths
- It is up and running
- Correlator is more powerful
- Sensitivity comparable to MeerKAT
- Baseline distribution, angular resolution of 5”

and most collecting area at spacings > 2 km

Weaknesses

It is a multi user instrument and it

will be harder to schedule large amounts of time

Relatively small FOV

Uniquely suited to do deep imaging at high redshifts

Main scientific motivation for CHILES

HI morphology as function of location in underlying large scale structure

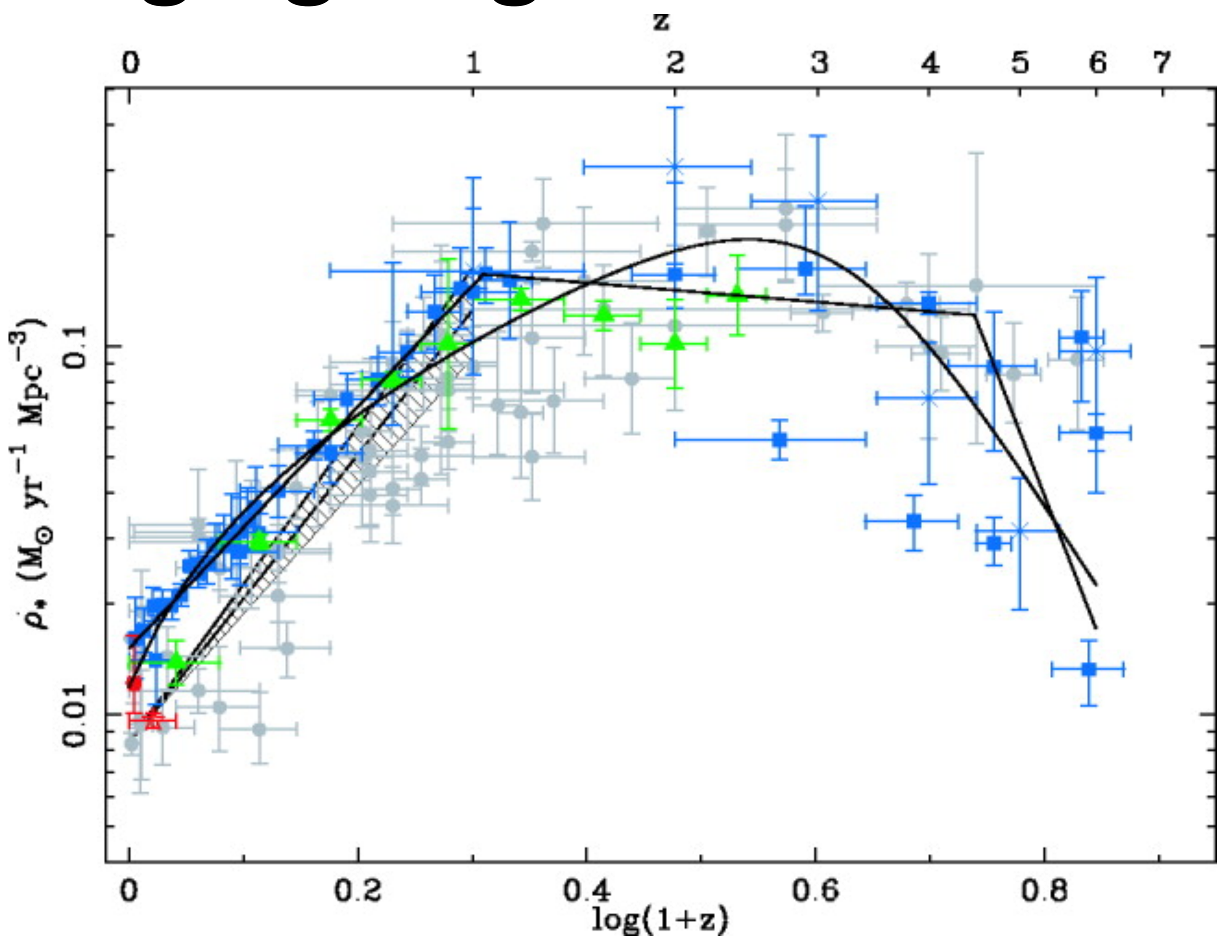
note that even at z=0.45 we will probably be able to say whether HI is inside or outside a galaxy

HI content, morphology and kinematics of individual galaxies
HI mass function as function of z and environment
Cosmic neutral gas density as function of z
Evolution of Tully Fisher relation

Very deep continuum studies (sub microJy)
source counts, star formation versus AGN

Transients.. Good overlap with transient surveys at other wavelengths, i.e. Pan-STARSS

HI imaging of galaxies z=0 to z=0.45



Evolution of Star Formation Rate Density (Hopkins and Beacom 2006)

Gas is the fuel for star formation Images tell how galaxies get and lose their gas

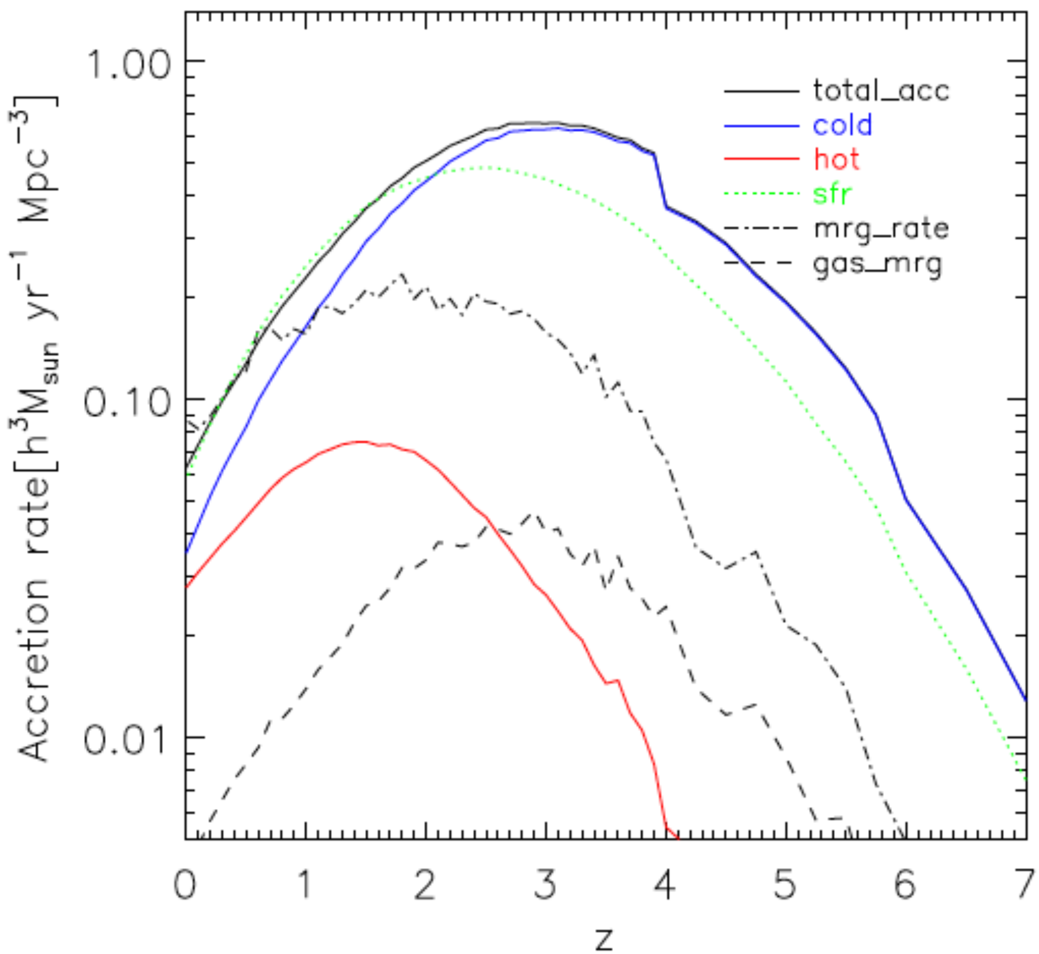
We (sort of) understand how large scale structure grows, but how galaxies form and evolve is less well understood.

Hierarchical galaxy formation in "standard" LCDM, used to make galaxies grow by merging, but the importance of gas accretion was underestimated and the physics misunderstood.

There are two ways for galaxies to grow

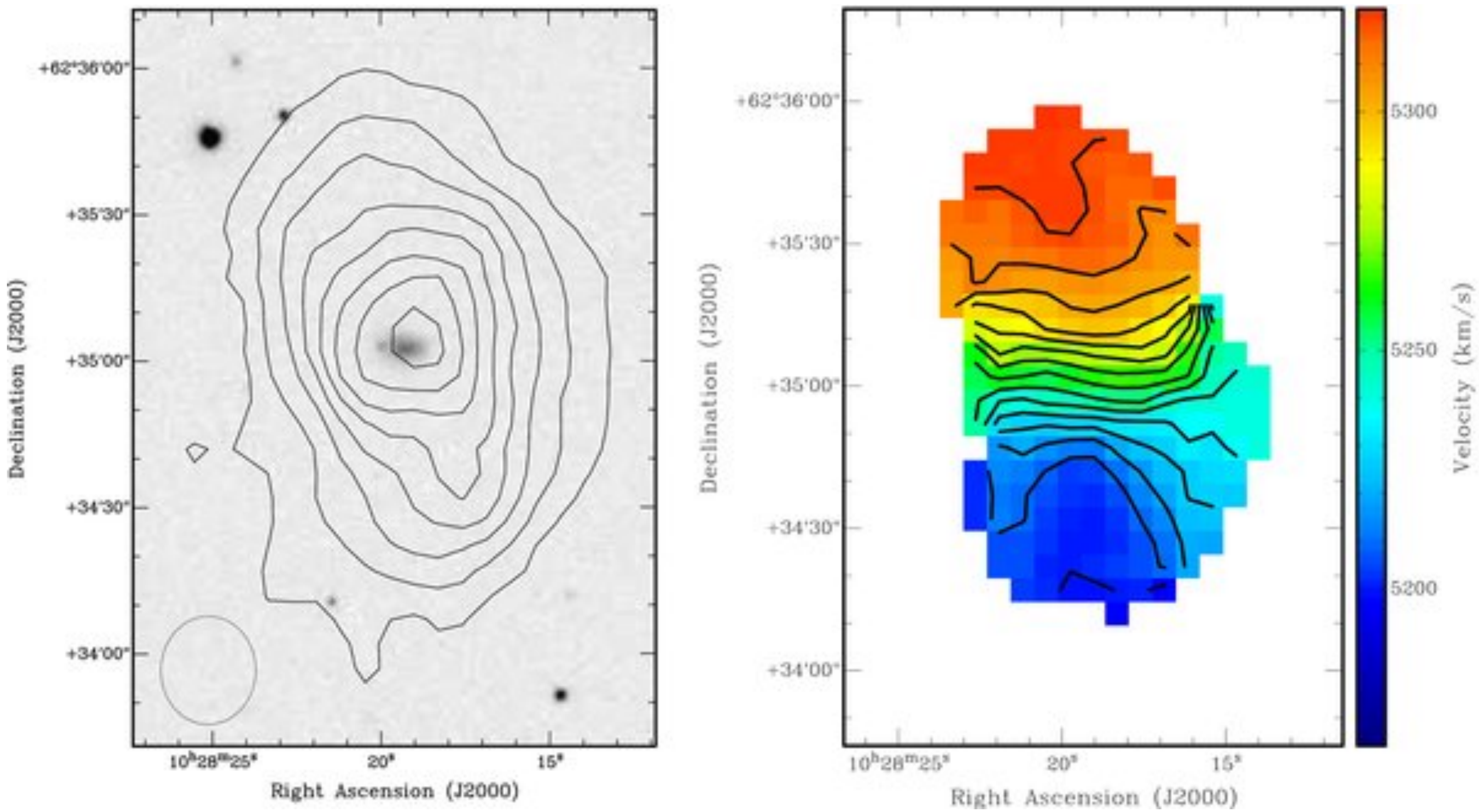
1) Merging with smaller galaxies can add gas and stars

2) Smooth accretion of cool gas
   dominates gas accretion at all z
   dominates total accretion at z>1



Keres et al 2005, Dekel and Birnboim 2006, Binney 1977

The void galaxy survey



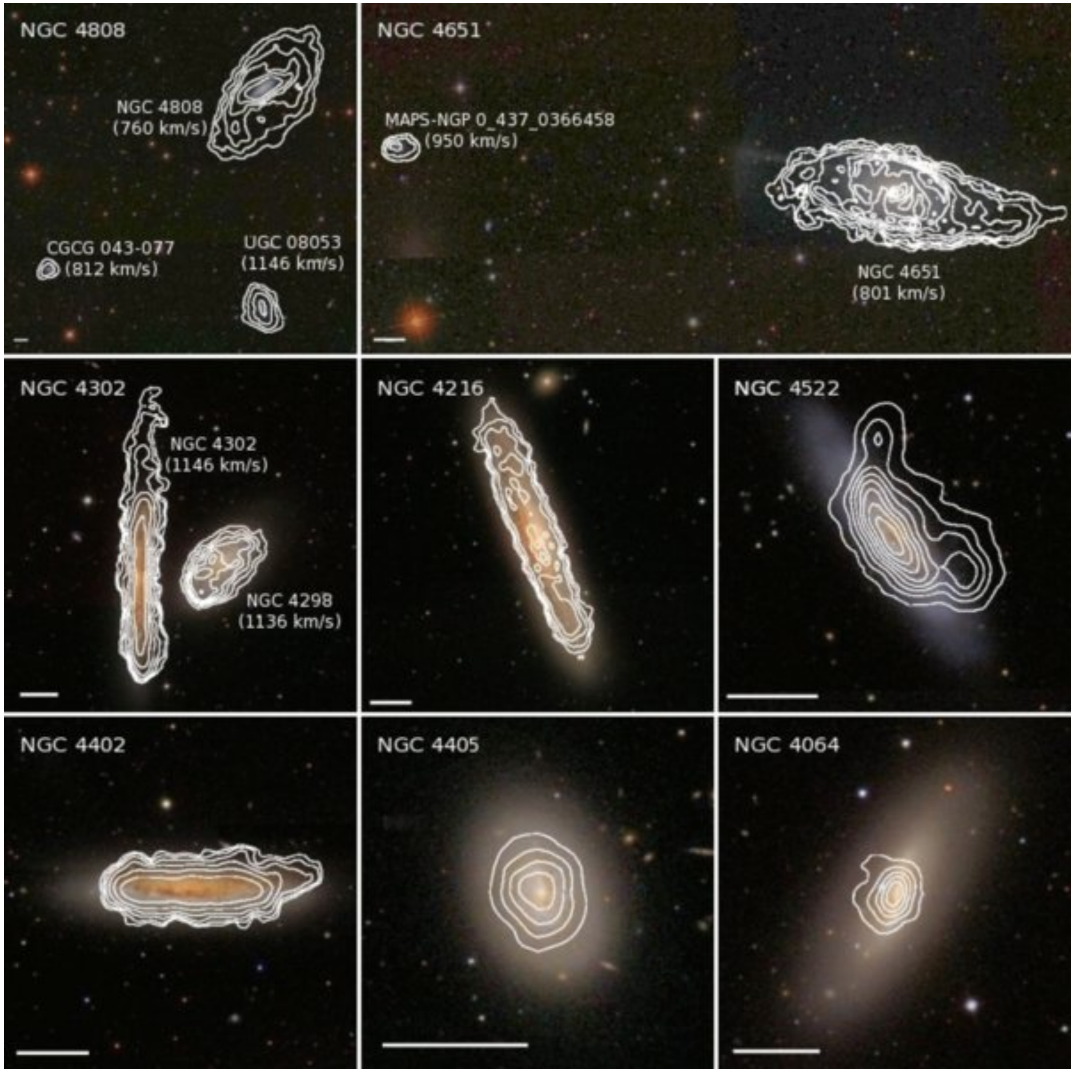
A polar disk

Stanonik et al 2009

Kreckel et al 2012   void galaxies are small and show many hints that they are still accreting gas

HI Images tell how galaxies get their gas

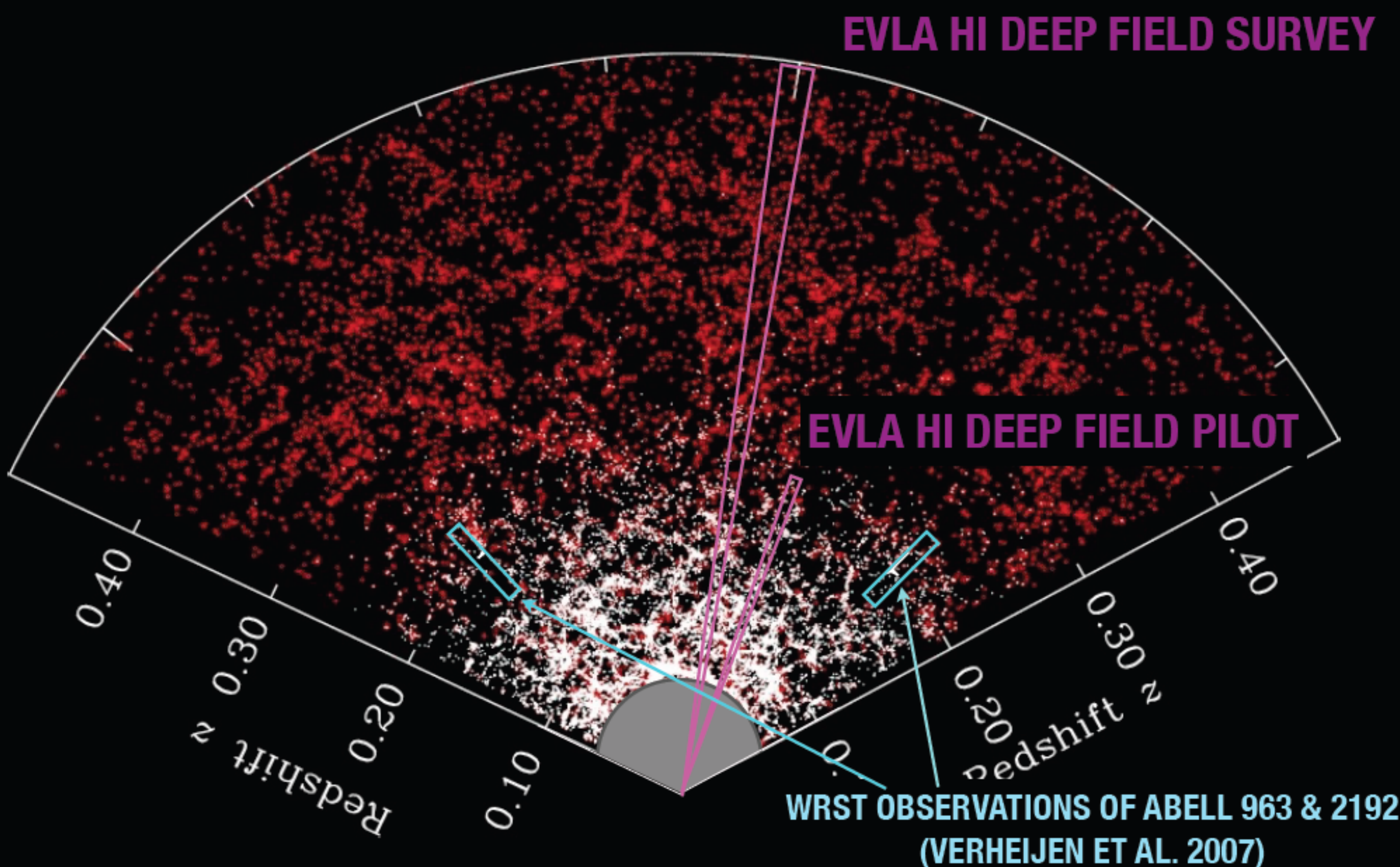
Galaxies in around the Virgo cluster VIVA



Chung et al, 2009

HI Images tell how galaxies lose their gas

HI surveys


EVLA HI DEEP FIELD SURVEY
EVLA HI DEEP FIELD PILOT
WRST OBSERVATIONS OF ABELL 963 & 2192
(VERHEIJEN ET AL. 2007)
0.10
0.20
0.30
0.40
Redshift z
0.20
0.30
0.40
Redshift z

A pilot for an EVLA HI Deep Field

One pointing in COSMOS field

Fernandez, Hess, Momjian, Pisano, Oosterloo, JvG (the human calibration pipeline)
Popping, Chung, Henning, Verheijen, Schiminovich, Scoville

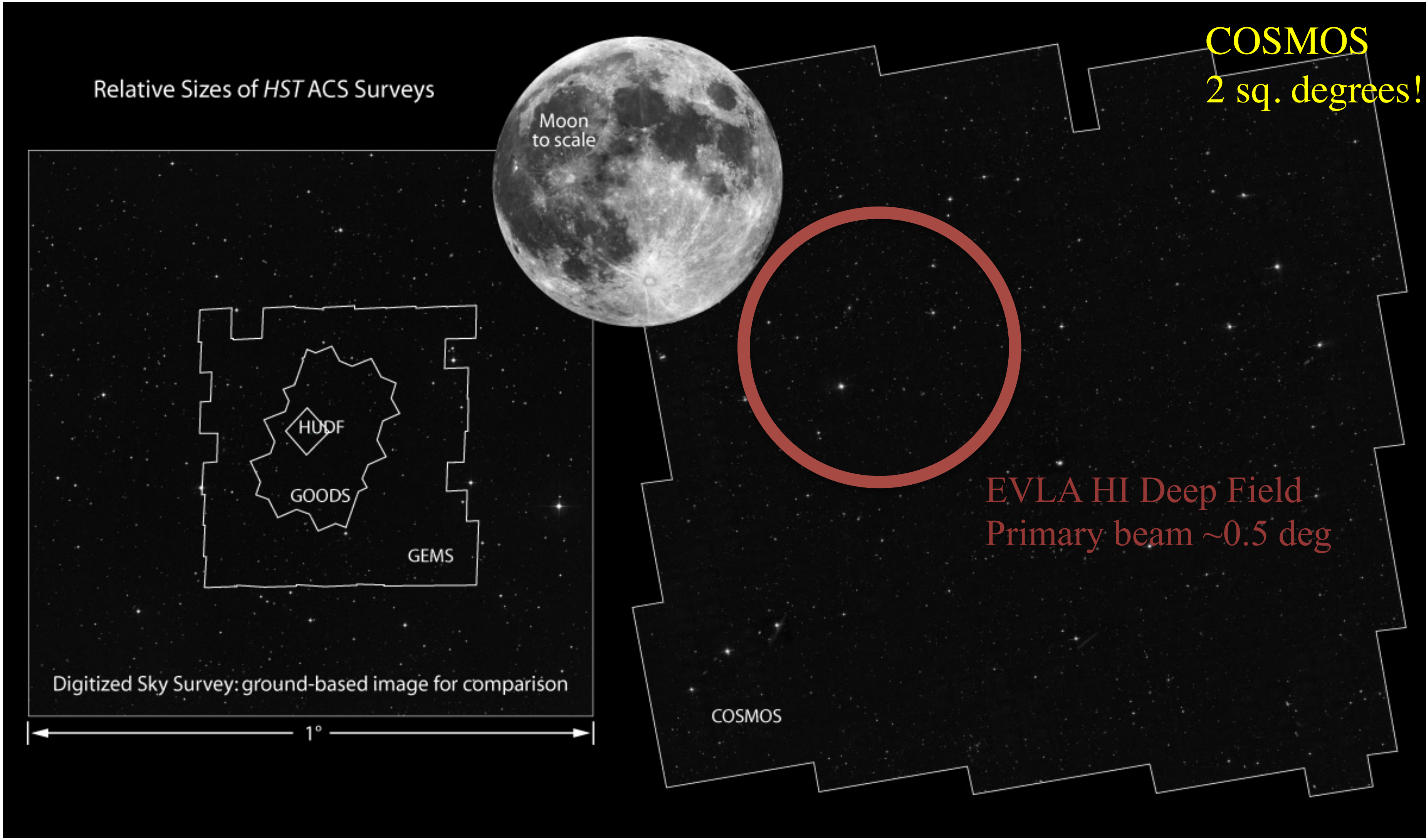
60 hours in B array (5 arcsec at z=0) , data taken in 2011.. 2.5 Tbyte

32 sub bands 16384 channels (1420-1190 MHz; z=0 to 0.2) vel resolution 3.3 km/s

Detection limits	z=0.07	$7x\ 10^{8}\ M_{sun}$
	z=0.13	$4x\ 10^{9}\ M_{sun}$
	z=0.2	$1.3 \times 10^{10}\ M_{sun}$

Column density sensitivity $3x10^{19}\ cm^{-2}$

Resolution	350 pc at 16 Mpc	17 kpc at z=0.2
FOV	150 kpc	7.5 Mpc



Additional coverage by:

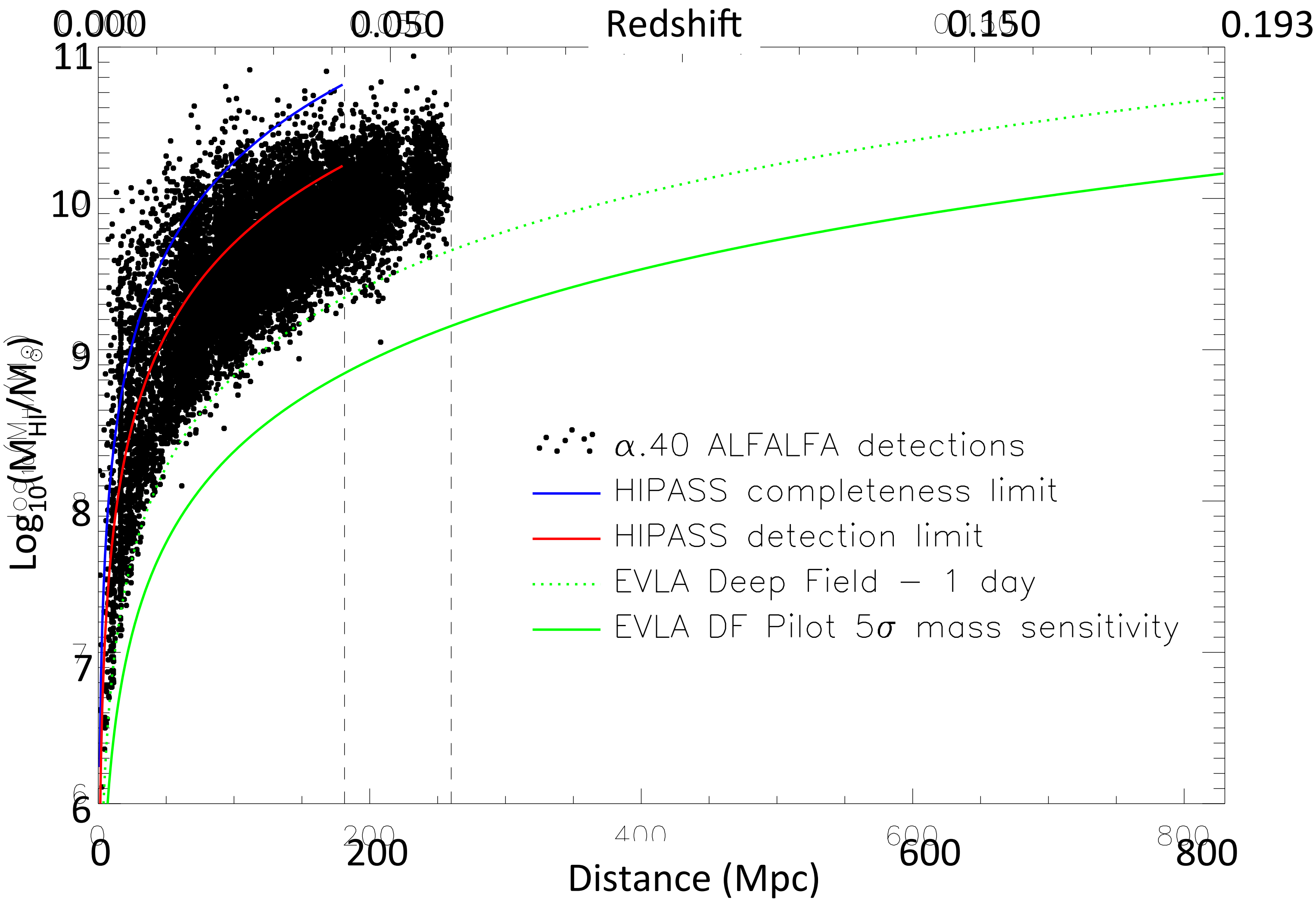
Spitzer, GALEX, XMM, Chandra

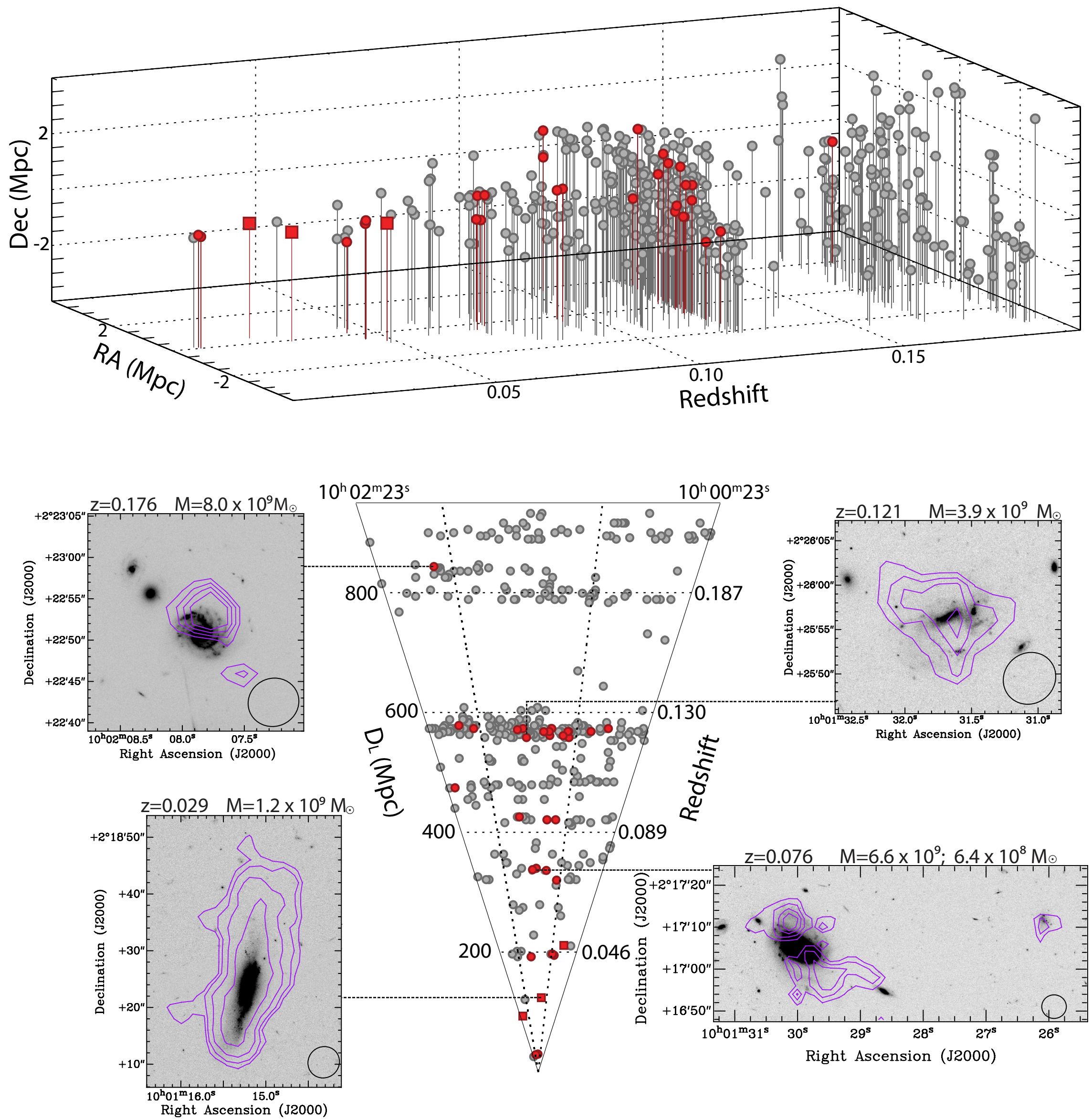
Subaru, VLA, ESO-VLT, UKIRT, NOAO, CFHT, CSO, CARMA, IRAM, Magellan

(Herschel, ALMA, APEX)

HI Mass Sensitivity

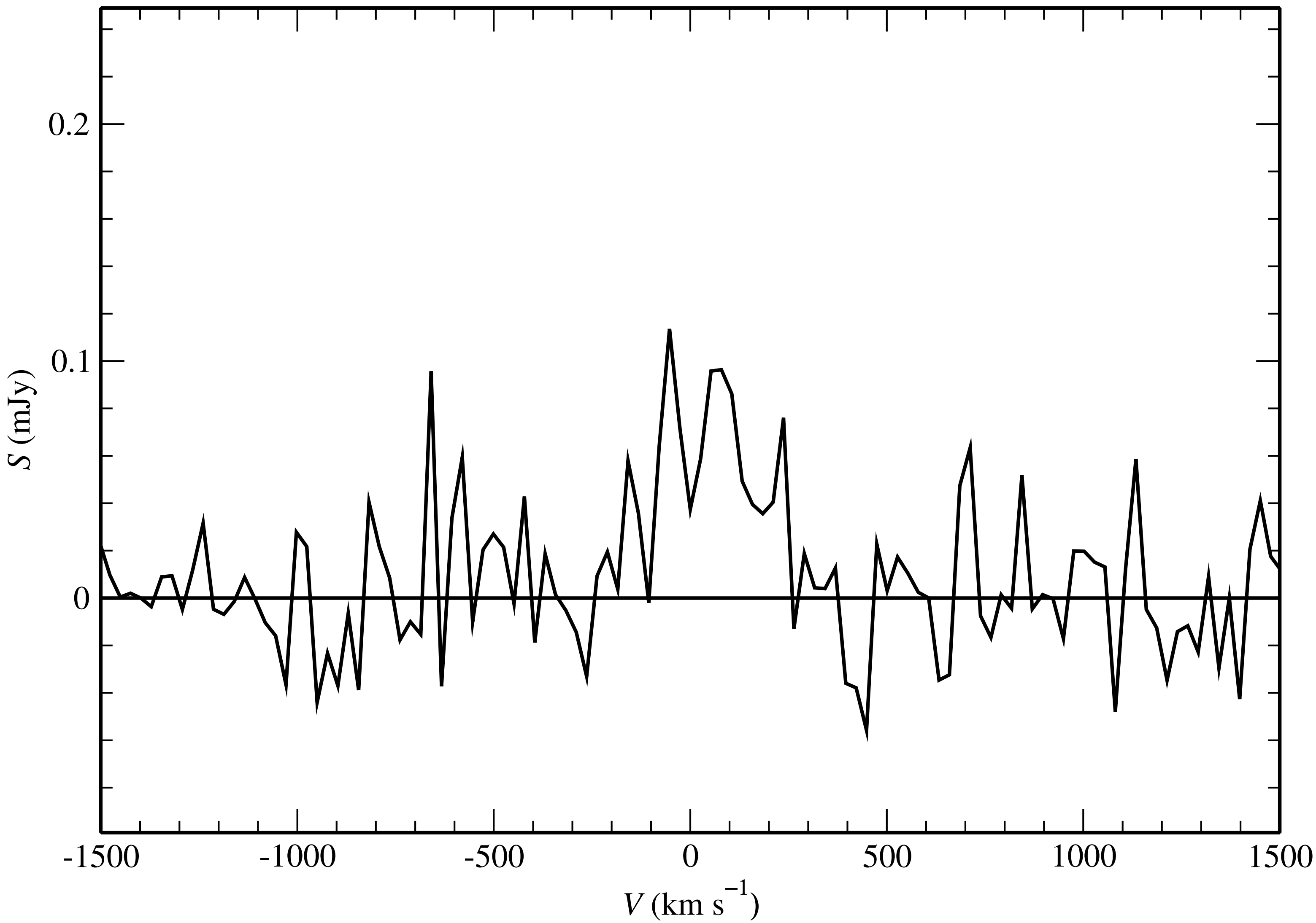
~Virgo, 16 Mpc	z=0.07	z=0.13	z=0.2
5σ M = $1.8\times10^{6}\ M_\odot$	$7\times10^{8}\ M_\odot$	$4\times10^{9}\ M_\odot$	$1.3\times10^{10}\ M_\odot$





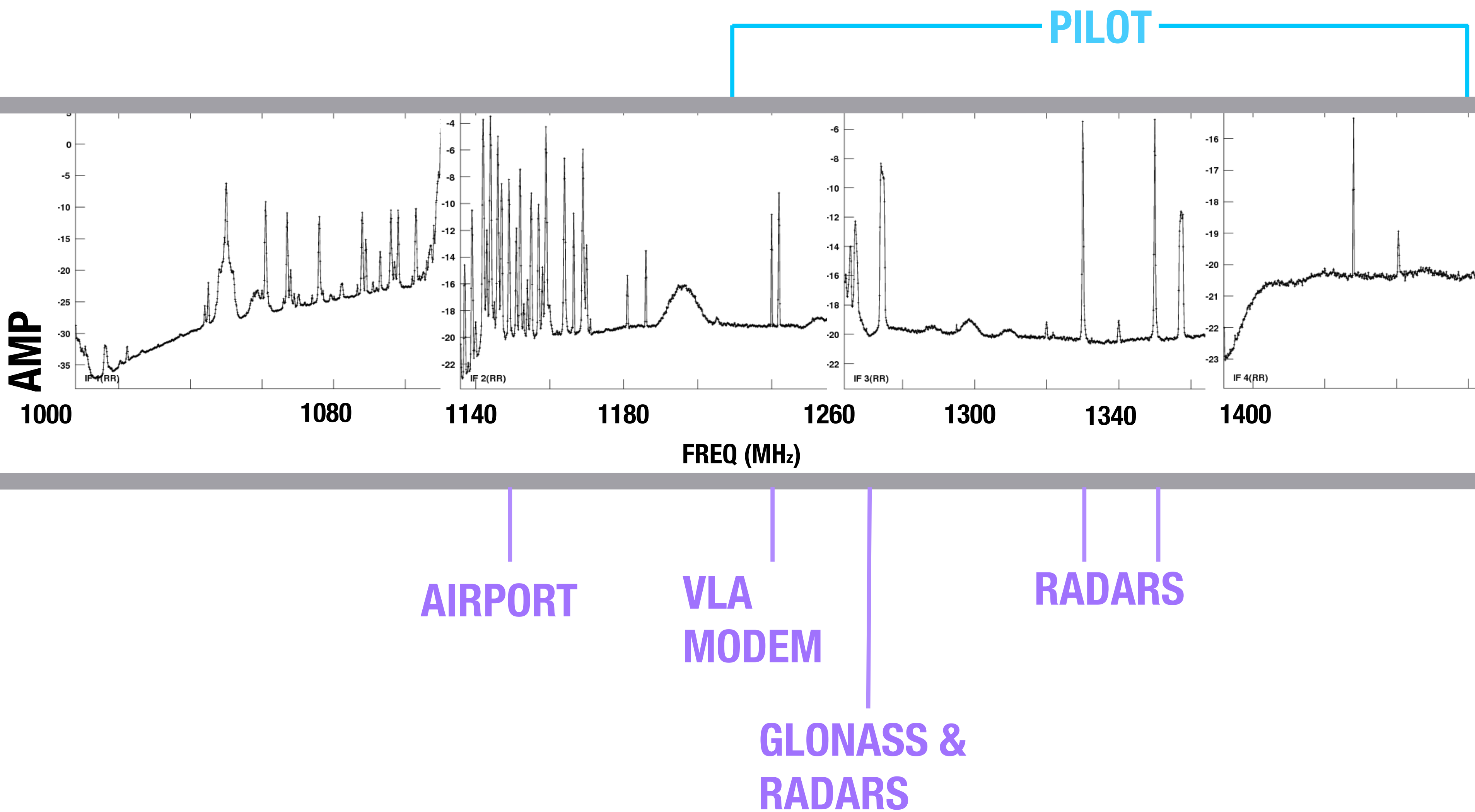
Results of pilot survey Fernandez et al 2013

Stacked signal of 80 galaxies in the wall

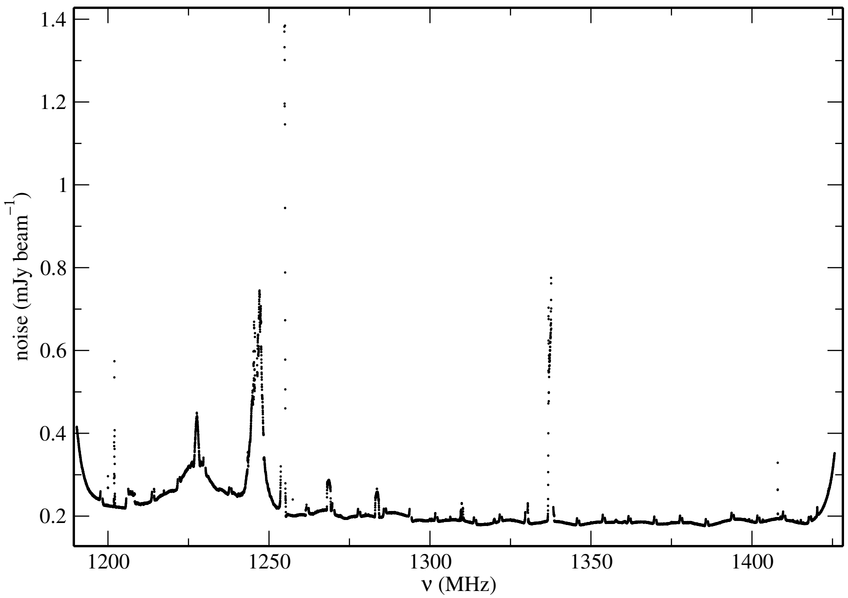


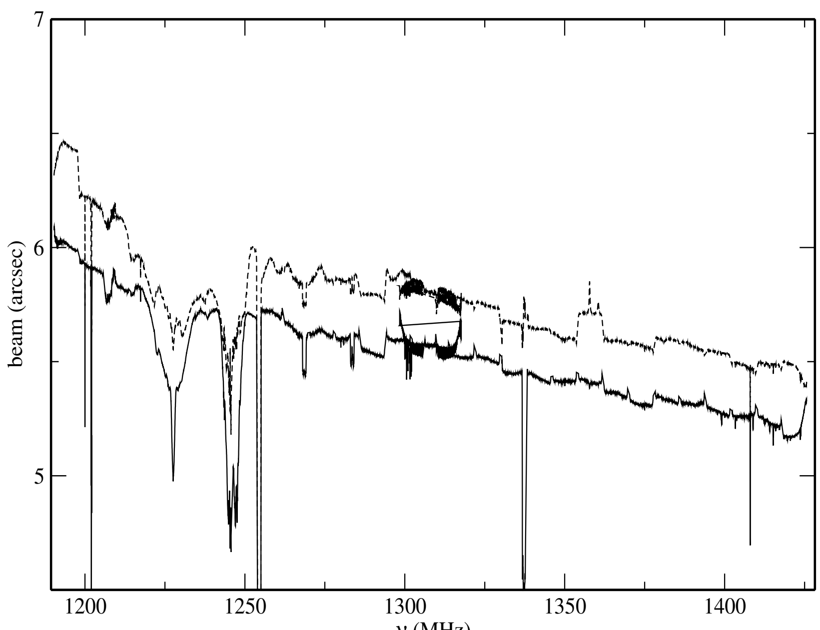
Average HI mass 1.8×10^9 M_{sun}

RFI in L-band


PILOT
AMP
IF 1(RR)
IF 2(RR)
IF 3(RR)
IF 4(RR)
1000
1080
1140
1180
1260
1300
1340
1400
FREQ (MHz)
AIRPORT
VLA
MODEM
GLONASS &
RADARS
RADARS

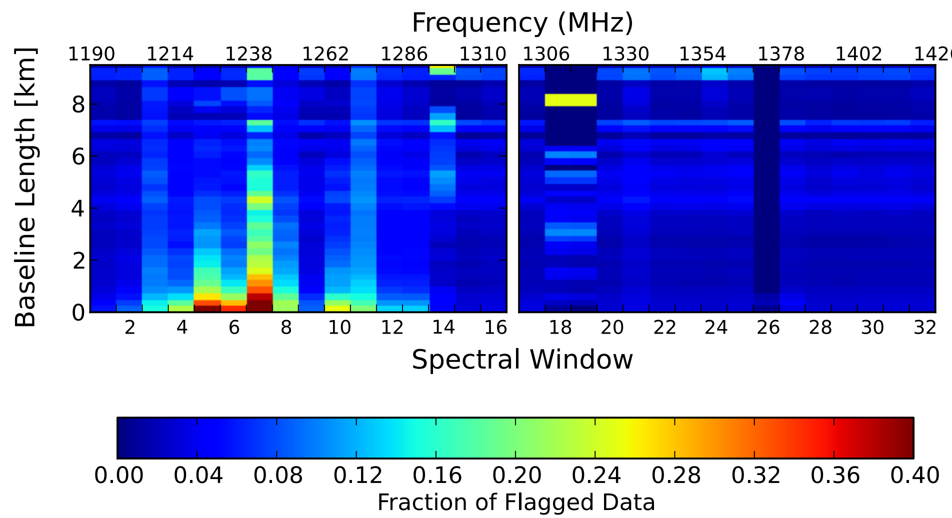
Rms noise as function of frequency





Synthesized beam

Now we realize JVLA really is the best!



CONCLUSIONS from PILOT

A real JVLA HI Deep Field is now possible

We have 33 detections over entire redshift range
Detections follow the large scale structure as defined optically

RFI is the main challenge

- Observing in B array mitigates the issue (avoid short spacings)
- Automatic flagging algorithms work reasonably well
- RFI will get worse.

Algorithms need be optimized to reduce data volume at every step

- example baseline dependent time averaging

A real HI deep field

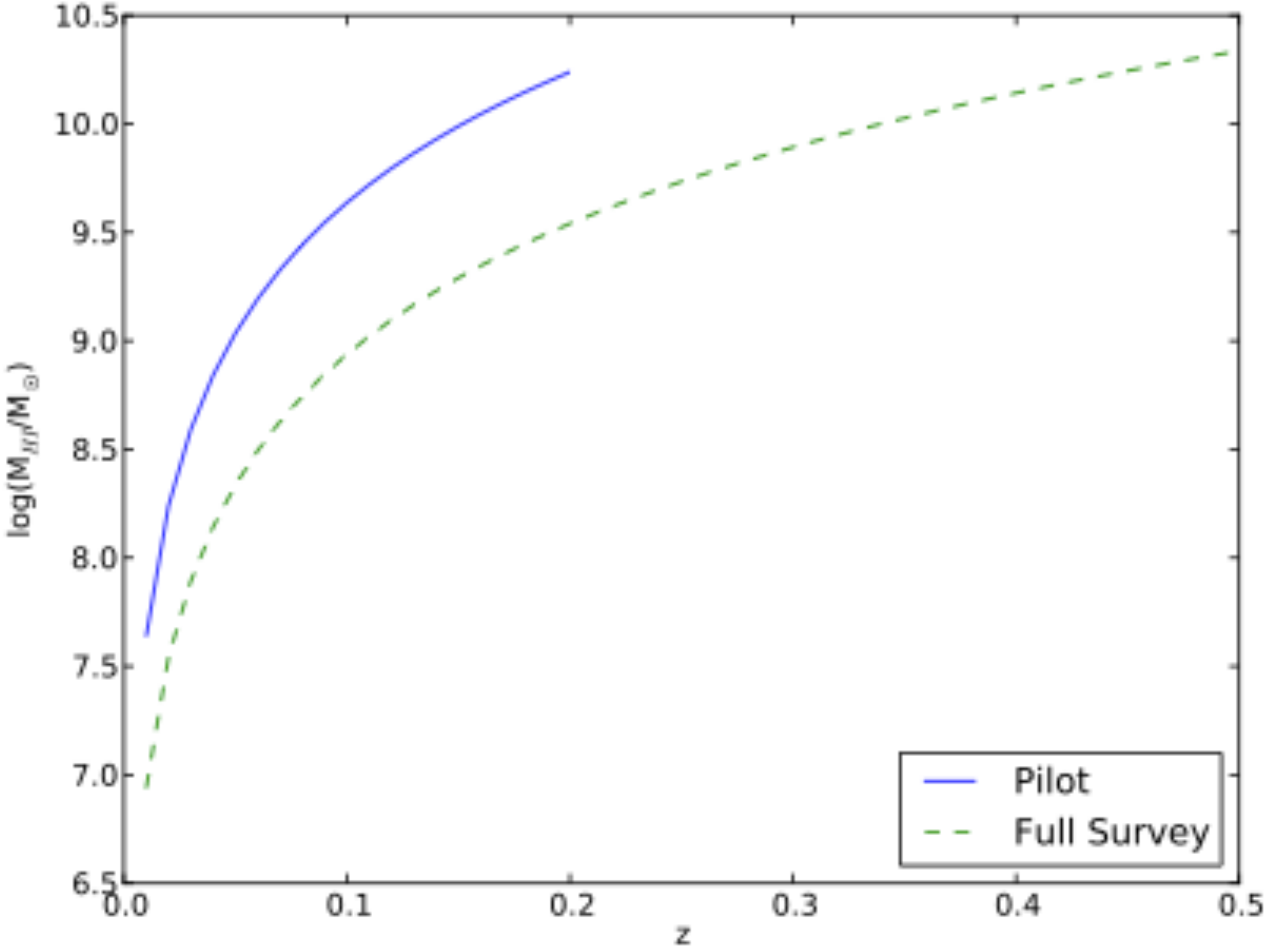
VLA is perfect telescope for this

B array has optimal distribution of spacings
correlator allows to probe z=0 to z=0.45
with 3.3 km/s velocity resolution

JVLA is up and running now (Thanks NRAO!!)

in 1000 hours on COSMOS..
mass limit 3×10^{10} M_{sun} at z=0.45

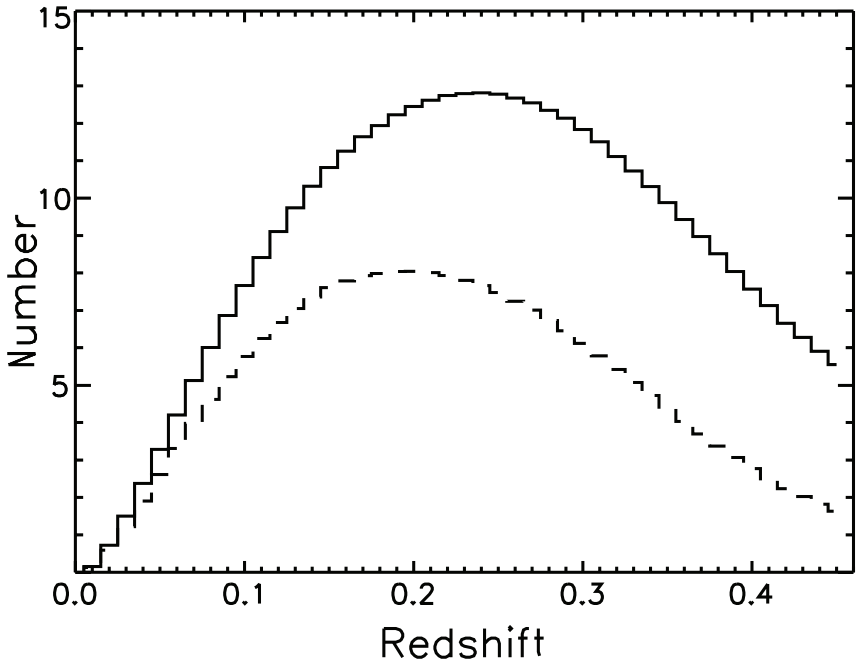
Full Survey

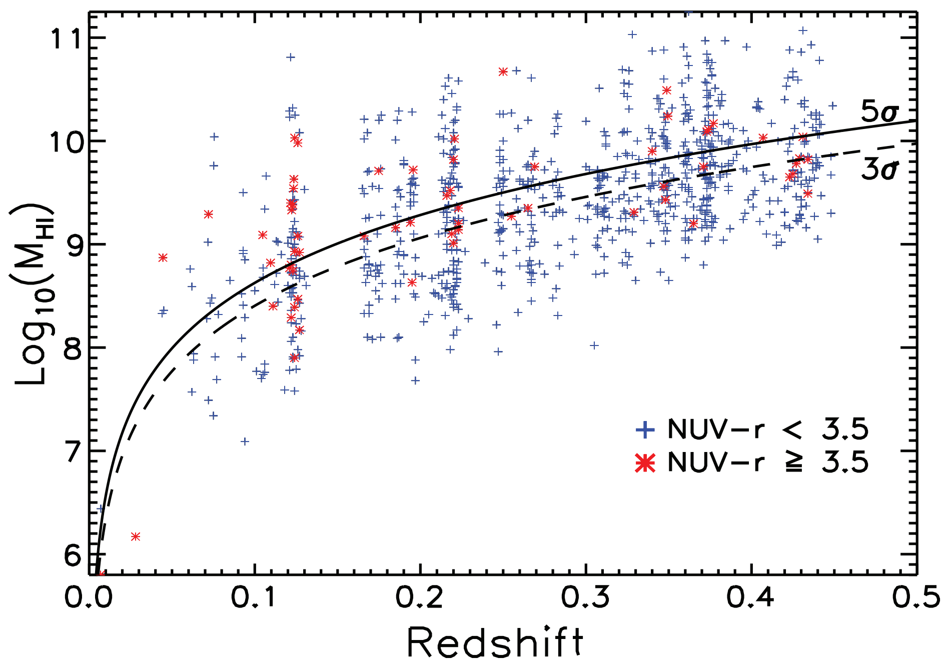


We aim to have same mass limit at z=0.45 as we had in pilot at z=0.2

Expected detection rates for 1000 hour project

We expect about 300 direct detections.. i.e. HI IMAGES

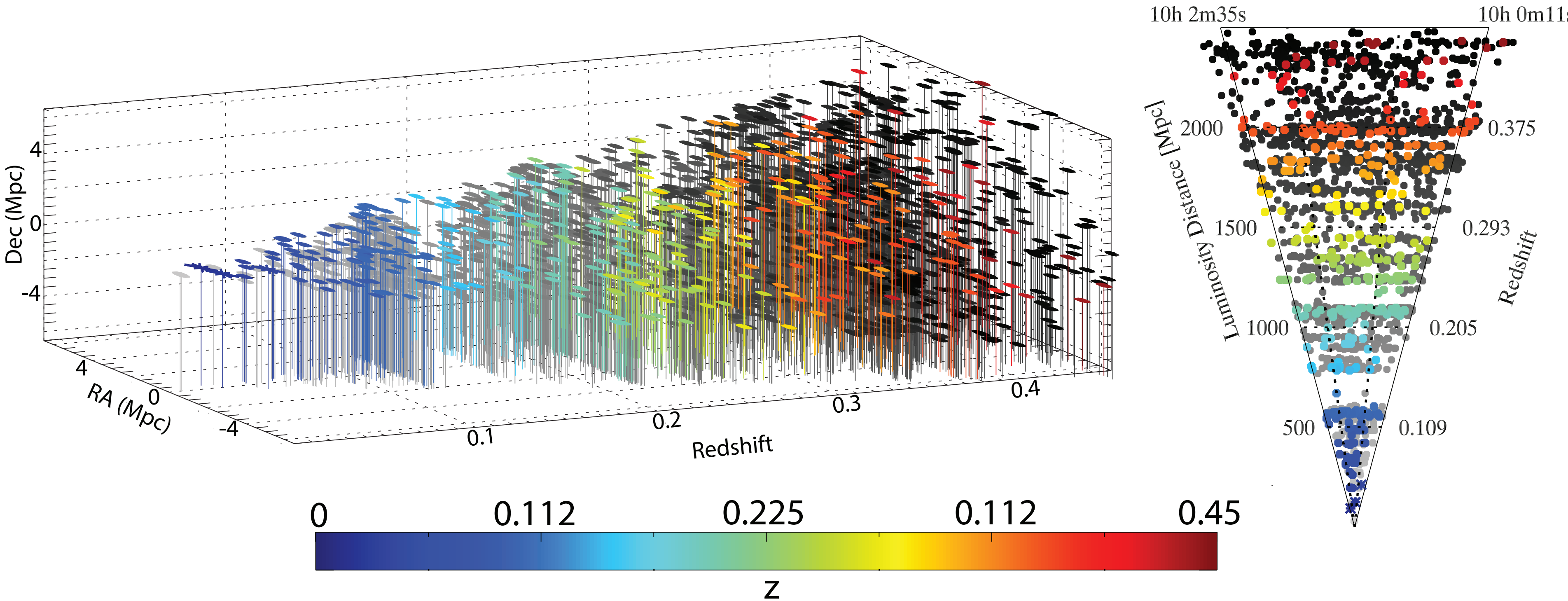




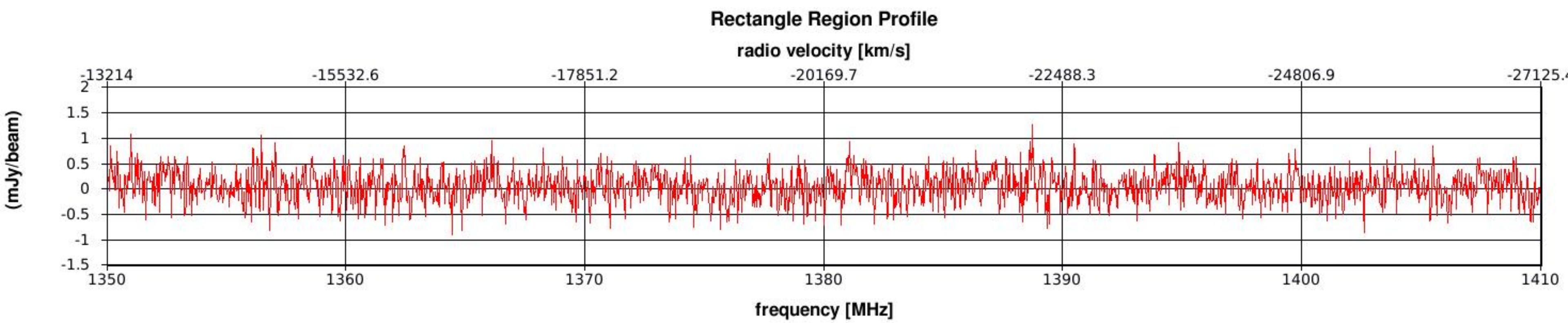
Estimate based on HI mass function

Estimate based on photometric gas fraction

Spatial distribution of predicted 5 sigma detections



We are up and running!   We already got 160 hours with 31000 channels to z=0.45



In the meantime, we really are not wasting telescope time

COMMENSAL OBSERVING by CHRIS HALES et al

Chiles con polarization