CHILES

COSMOS HI LARGE EXTRAGALACTIC SURVEY

Jacqueline van Gorkom, Ximena Fernandez, Kelley Hess, D.J. Pisano, Kathryn Kreckel, Emmanuel Momjian, Attila Popping, Tom Oosterloo, Laura Chomiuk, Marc Verheijen, Patricia Henning, David Schiminovich, Matthew Bershady, Eric Wilcots, Nick Scoville

(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, Natascha Maddox

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

Key HI Science of SKA

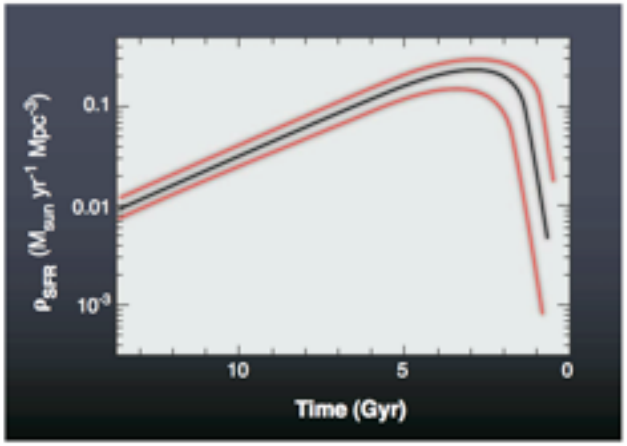


Fig. 2. A simple representation of our current knowledge of the rise and fall of globally averaged star-formation activity over the 13.7 billion years of cosmic history.

- **HI and galaxy evolution**

  Resolved studies of HI emission in and around galaxies from z = 0 to beyond z = 1.

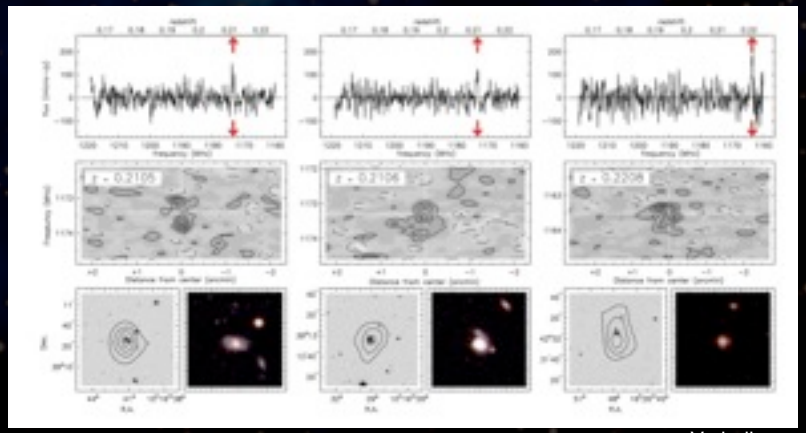
- Provide, for large part of the life span of the Universe, information about the cold-gas in galaxies and their environment for multi-wavelength, multi-archive studies of galaxies evolution.

- After initial 'burst' of star formation, *overall* star formation declined by factor 10

- But star formation history of individual galaxies can be very different

  Why???

- SKA Pathfinders will cover (part of) this redshift range, but most detections will be **unresolved**.



Verheijen

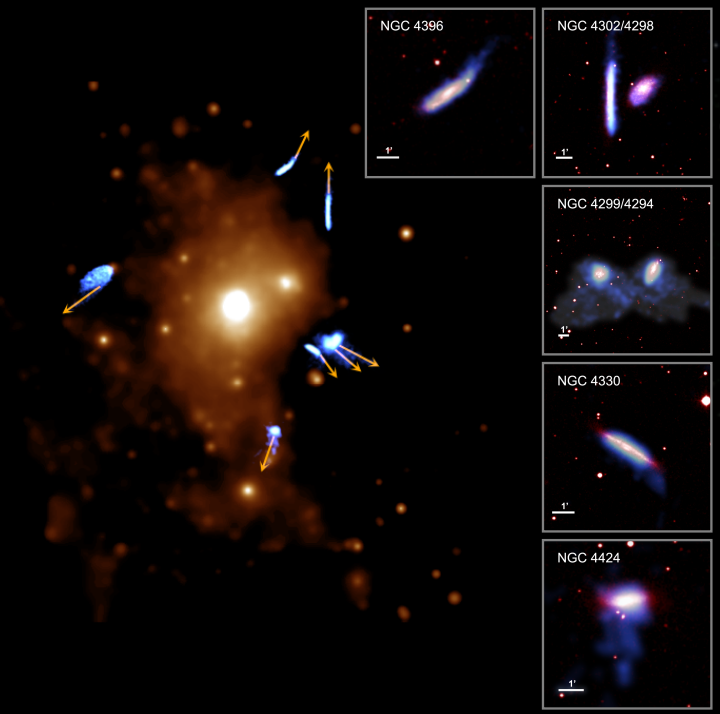
Why resolve galaxies?

- SKA Pathfinders will study HI and galaxy evolution, but most detections will be **unresolved**.
- Gas of galaxies content determined by balance of
  - consumption by star formation
  - gas loss by stripping & interactions
  - accretion of gas (companions; directly from IGM)
- Current gas consumption timescale in spirals < Hubble time $\langle \tau_{\rm gas} \rangle = \frac{\rho_{\rm gas}}{(1-R)\ \rho_{\rm SFR}} \sim 4 \times 10^9 {\rm yr}$ so this is a dynamic process
- HI imaging is a tool to determine part of this balance; as function of galaxy type, environment, redshift, …

  Galaxies are more than dots in scatter plots

Why resolve galaxies?

HI imaging: stripping



Red: Hα (Kenney et al)
Blue/Green: HI (Oosterloo & van Gorkom)

Chung+ 2009

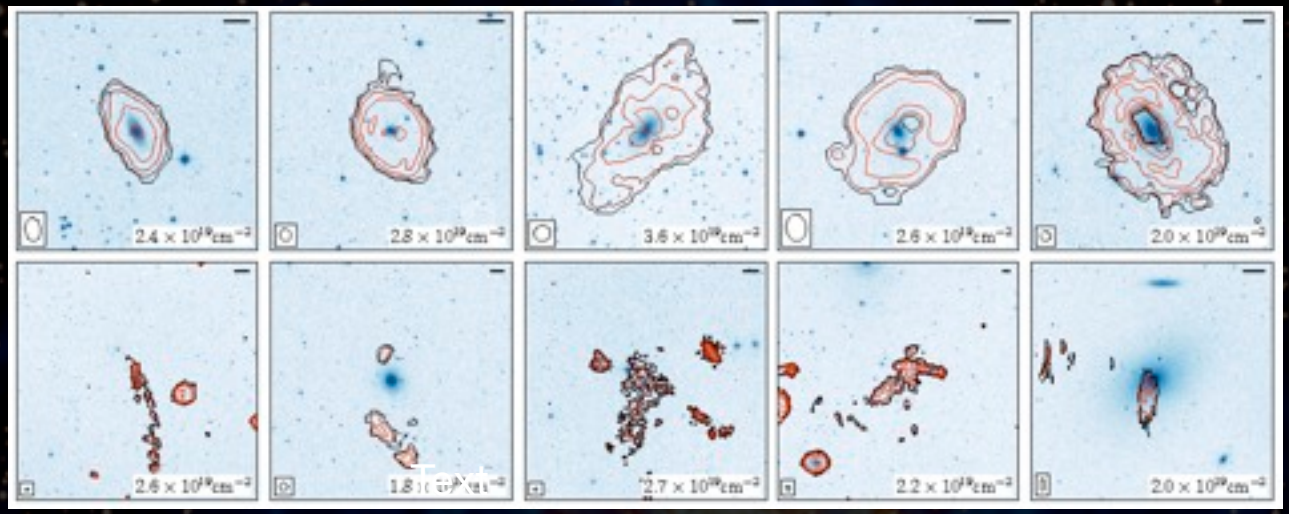
Why resolve galaxies?

HI in early-type galaxies

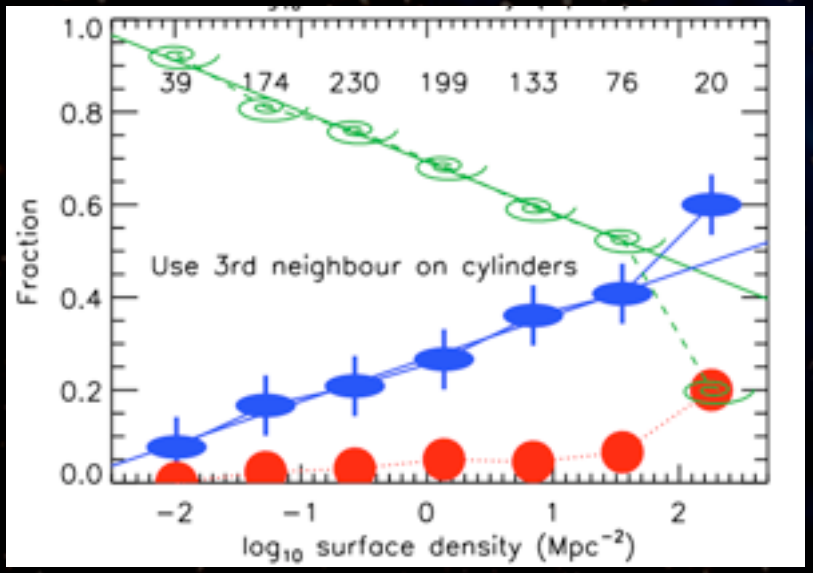
- Morphology is key

low-density field

high-density field



Serra+ 2012

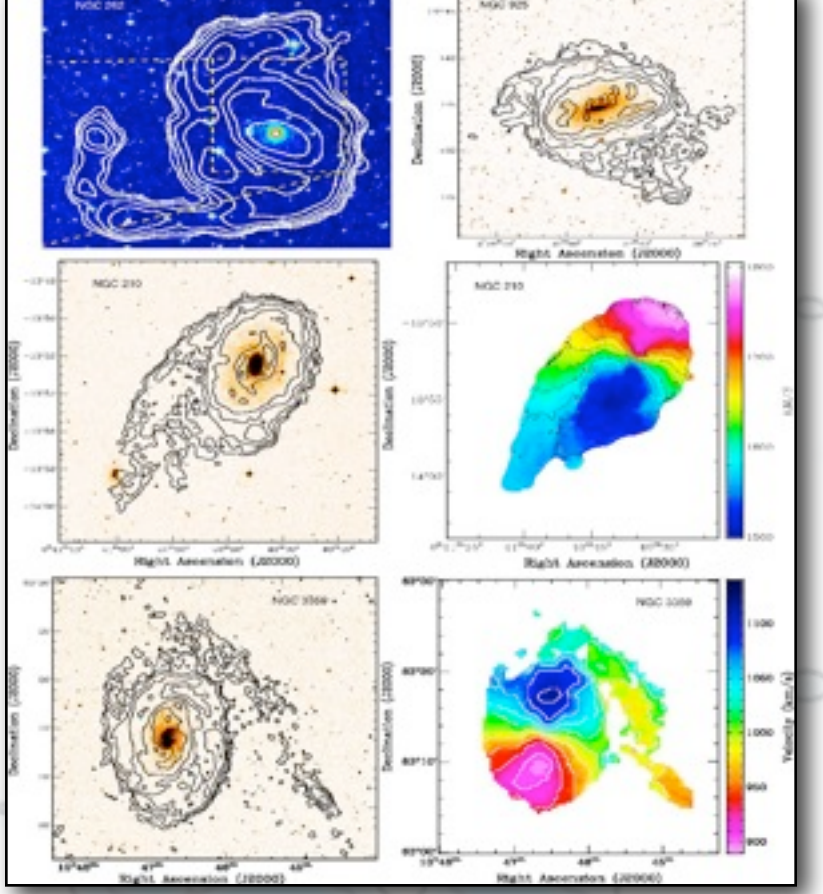


morphology-density relation (ATLAS^{3D})

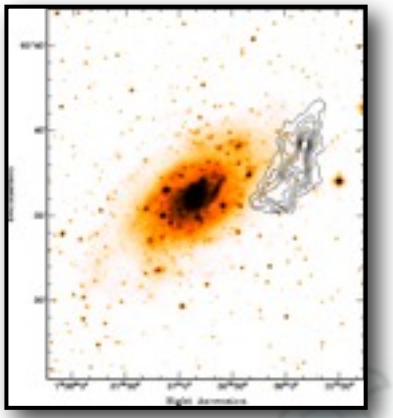
Why resolve galaxies?

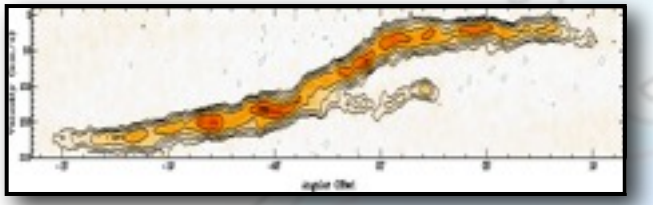
Minor mergers: how much HI?

- Many nearby spirals show signs of small accretions/interactions
- Usually only small amounts of HI involved: up to few x 10^8 Msol

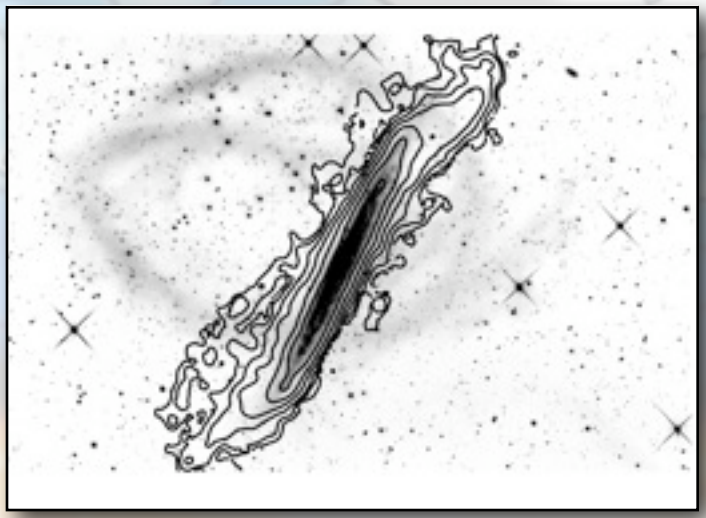


Sancisi+ 2008



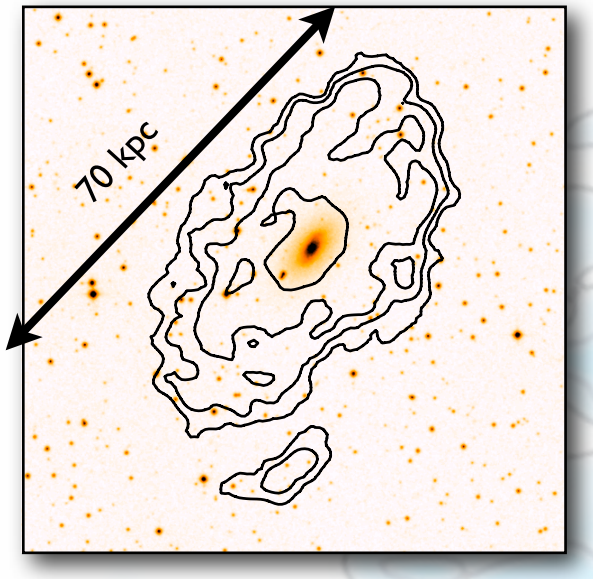


Fraternali+ 2002



Why resolve galaxies?

- Sometimes you find an interesting surprise



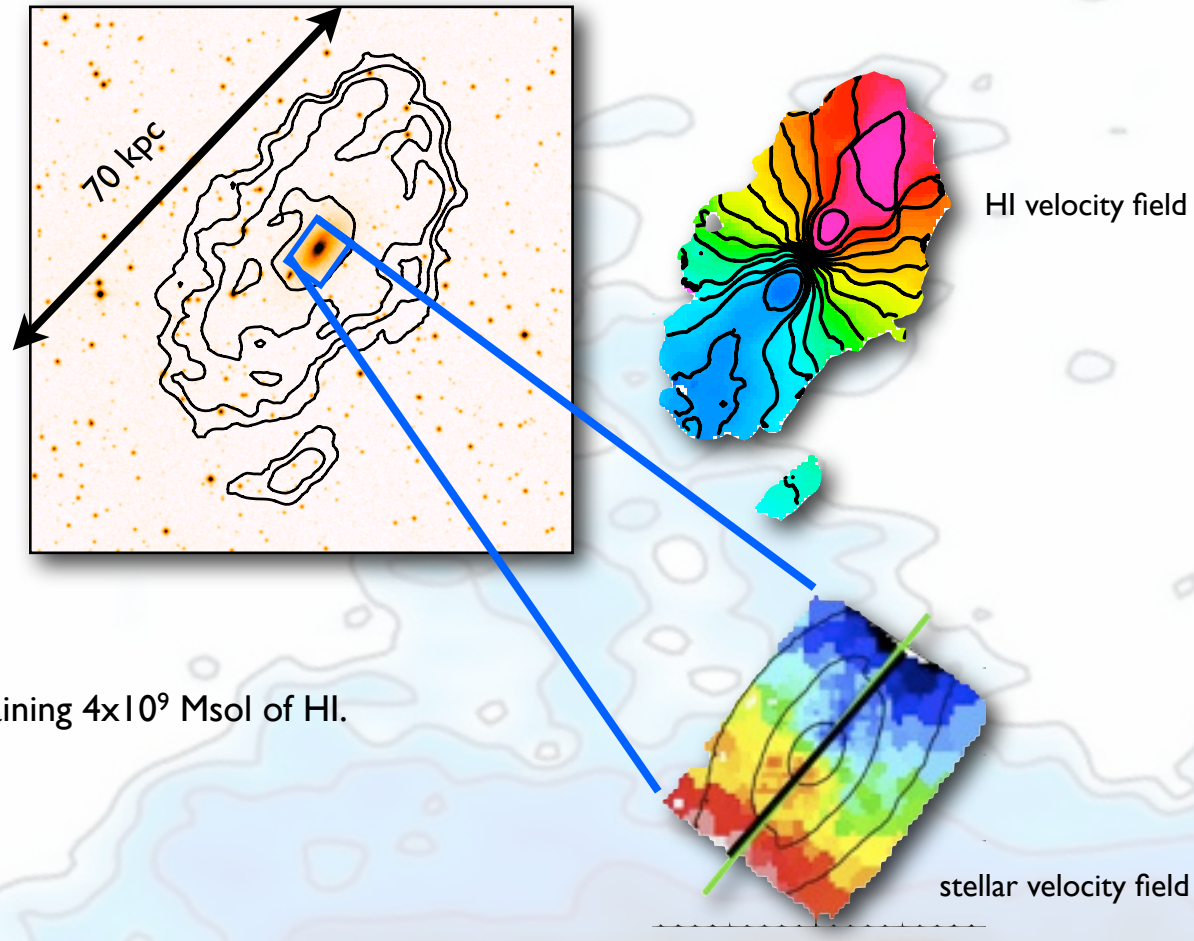
HI velocity field

NGC 6798

ETG with large, regular HI disk containing 4×10^9 Msol of HI.

Why resolve galaxies?

- Sometimes you find an interesting surprise



NGC 6798

ETG with large, regular HI disk containing 4×10^9 Msol of HI.

counterrotating!!

Don’t wait for SKA...

Use EVLA!!

Strengths

- It is up and running (mostly...), can go to z ~ 0.4
- Now powerful correlator
- Sensitivity/Survey speed ‘comparable’ to MeerKAT/ASKAP/Apertif
- B-array: angular resolution of 5” : ~ 30 kpc at z = 0.4

Weaknesses

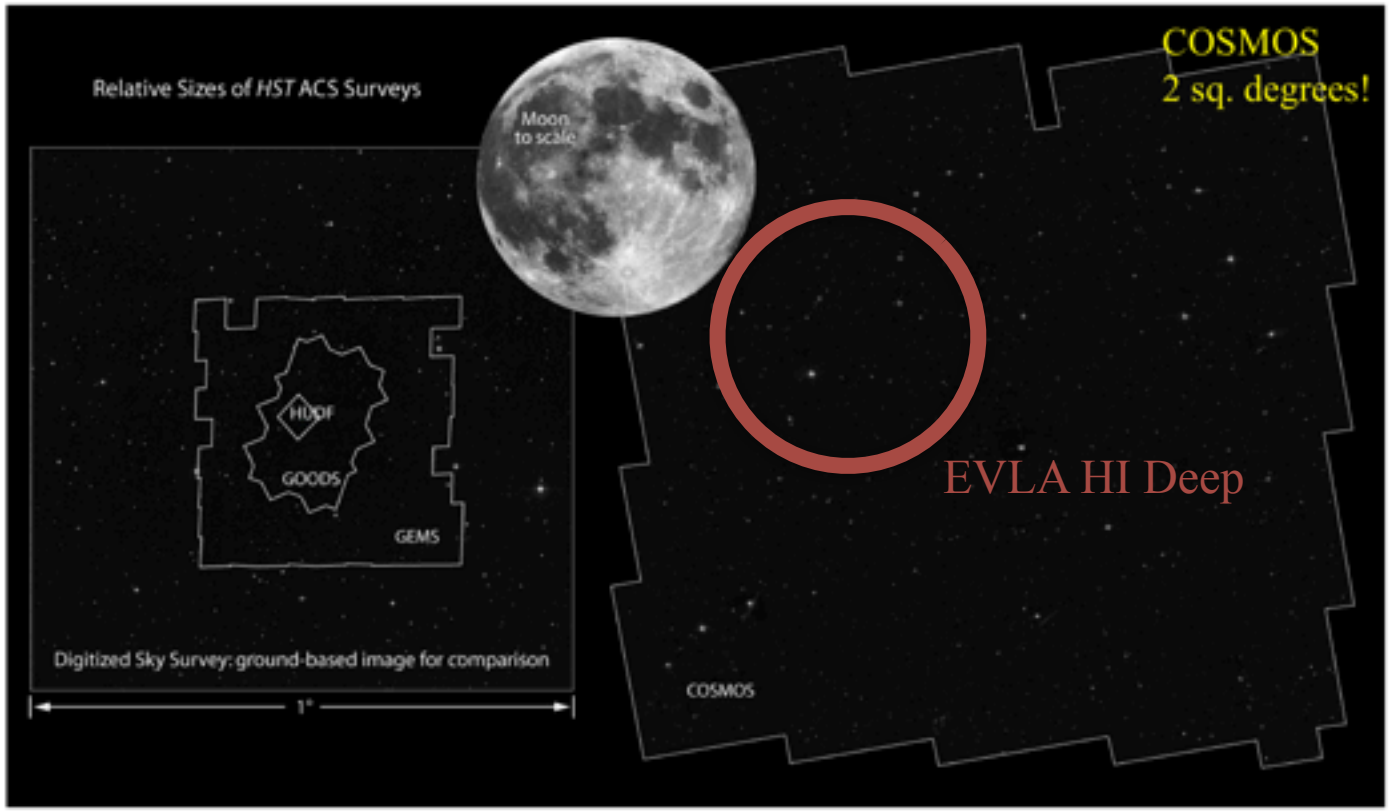
- It is an open, multi-user instrument and it will be harder to schedule large amounts of time
- Relatively small FOV

Well suited to do deep imaging at ‘high’ redshifts

CHILES

COSMOS HI LARGE EXTRAGALACTIC SURVEY

1000 hrs EVLA on the COSMOS field;
HI out to z = 0.45



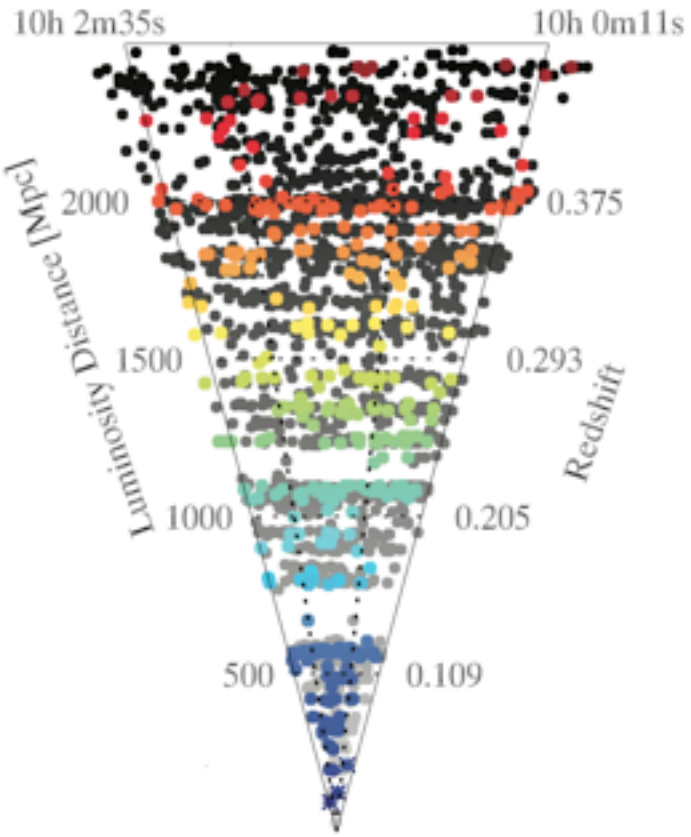
Additional coverage by:

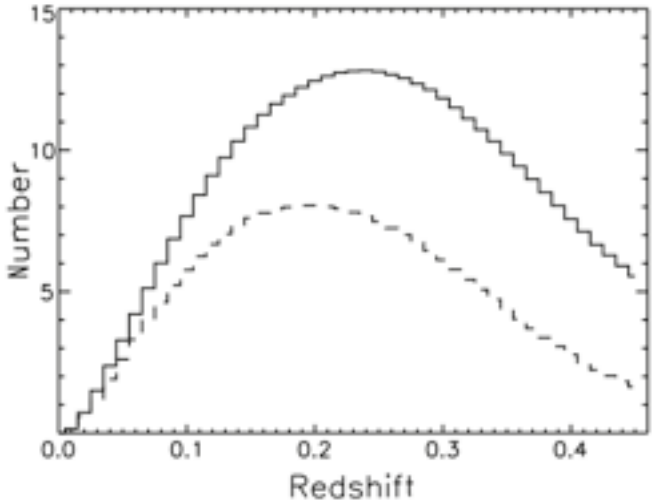
Spitzer, GALEX, XMM, Chandra

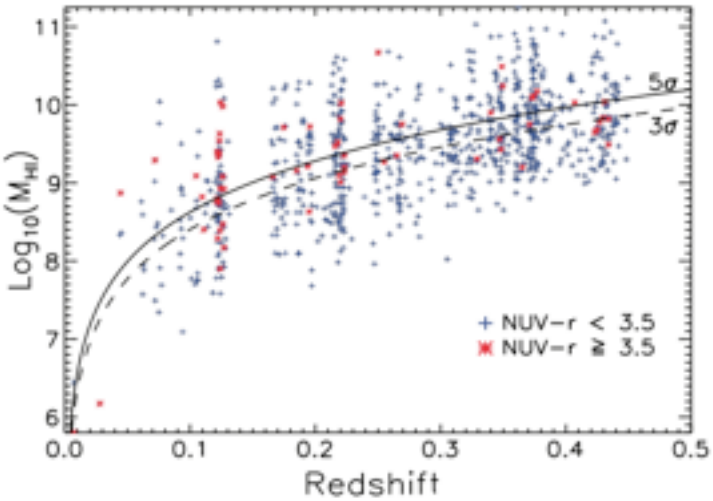
Subaru, VLA, ESO-VLT, UKIRT, NOAO, CFHT, CSO, CARMA, IRAM, Magellan

(Herschel, ALMA, APEX)

What we expect to see







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

(ApJ Letters, 2013, Fernandez et al)

50 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 7×10^8 M_{sun}

z=0.13 4×10^9 M_{sun}

z=0.2 1.3×10^{10} M_{sun}

Column density sensitivity 3×10^{19} cm^{-2}

Resolution 350 pc at 16 Mpc 17 kpc at z=0.2

FOV 150 kpc 7.5 Mpc

Goals of the PILOT

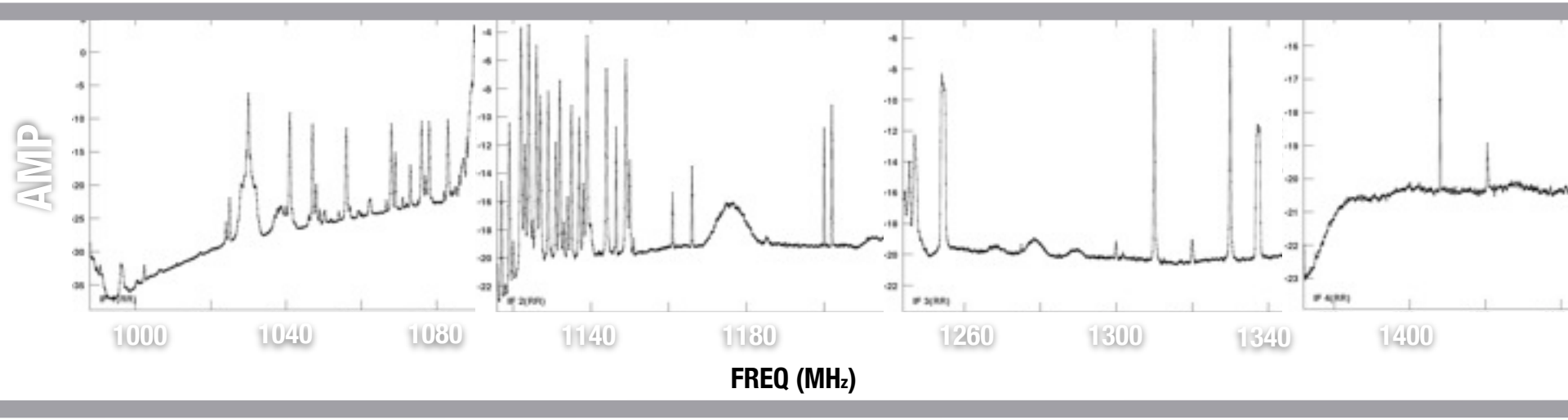
Can we handle the data volume (2.5 Tbyte)
calibration, data reduction done in AIPS
for full survey are using CASA

How bad is the RFI

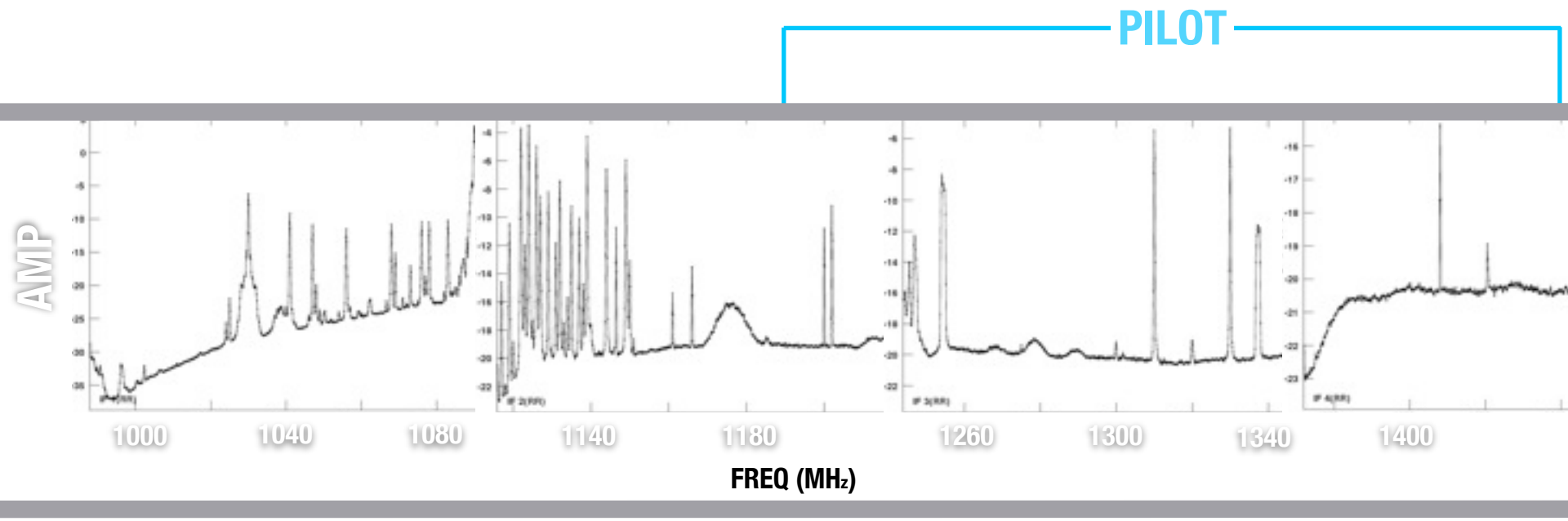
Can we reach theoretical noise

Develop/test source detection algorithms

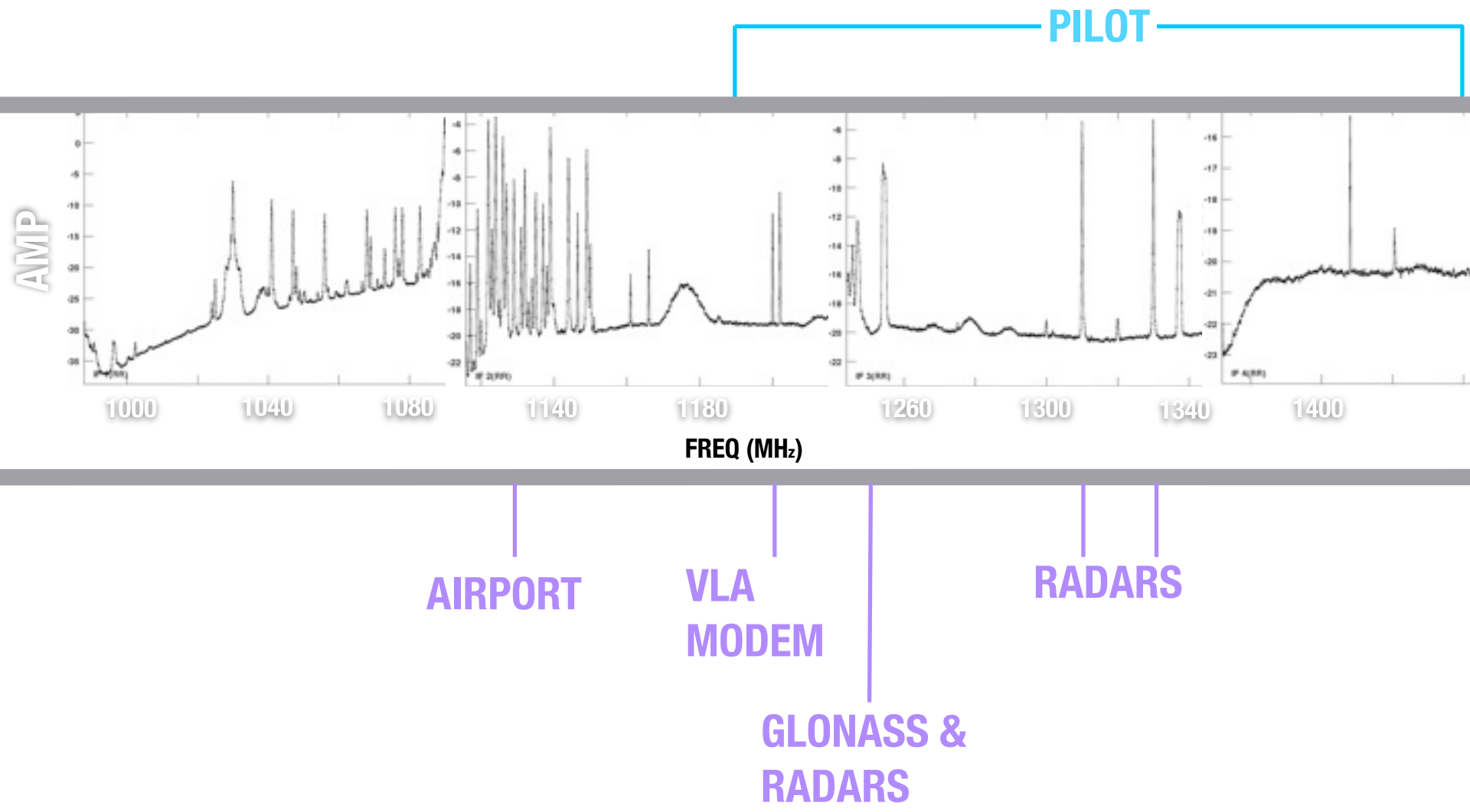
RFI in L-band



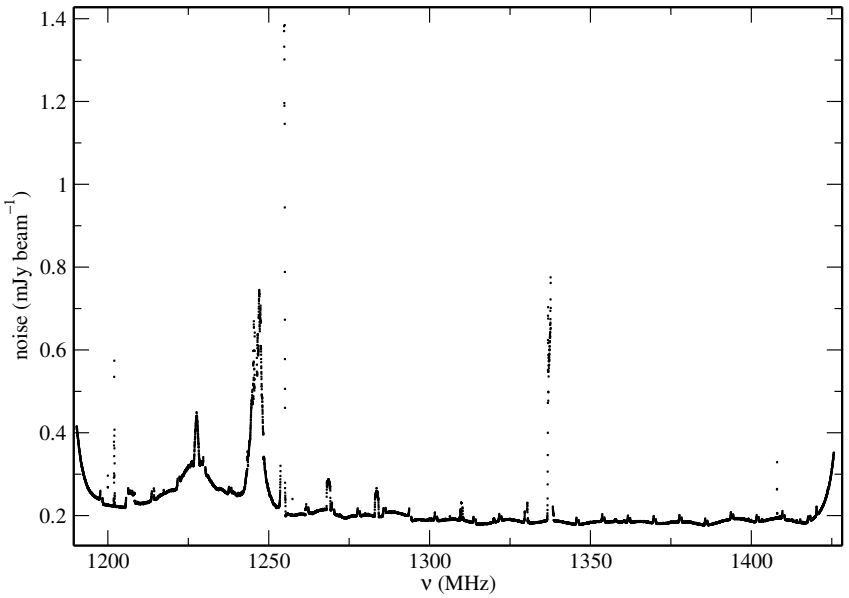
RFI in L-band

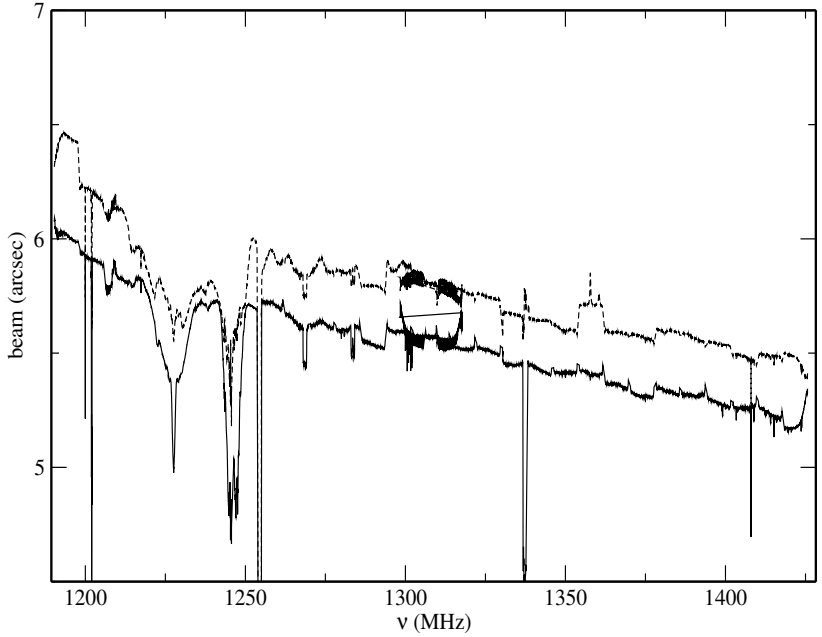

PILOT
AMP
1000
1040
1080
1140
1180
1260
1300
1340
1400
FREQ (MHz)

RFI in L-band


PILOT
AMP
1000
1040
1080
1140
1180
1260
1300
1340
1400
FREQ (MHz)
AIRPORT
VLA
MODEM
GLONASS &
RADARS
RADARS

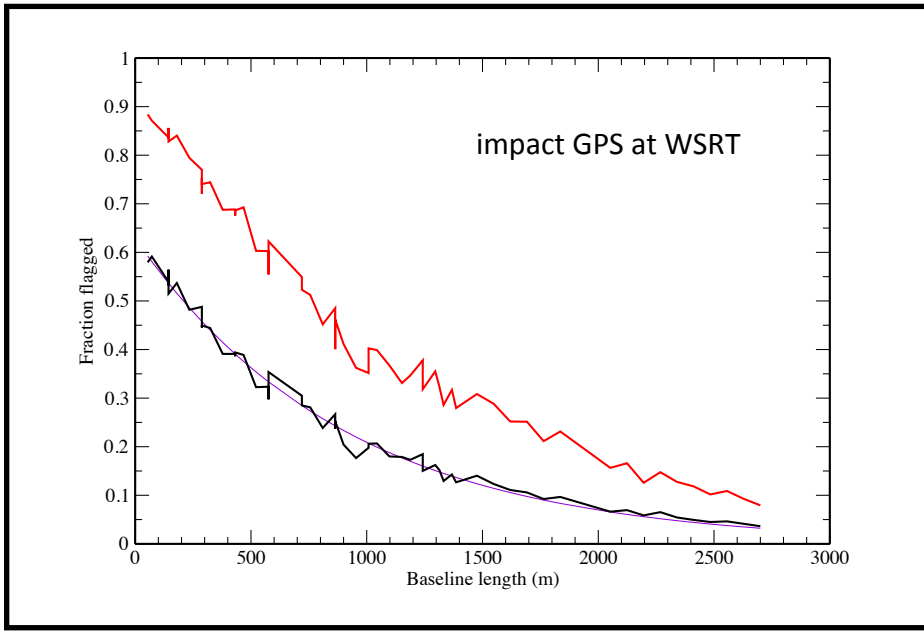
Rms noise as function of frequency

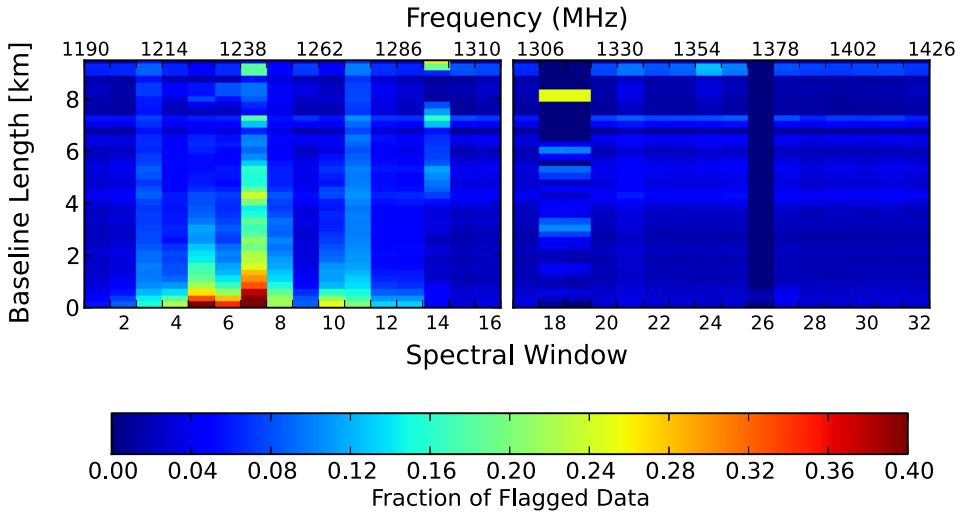


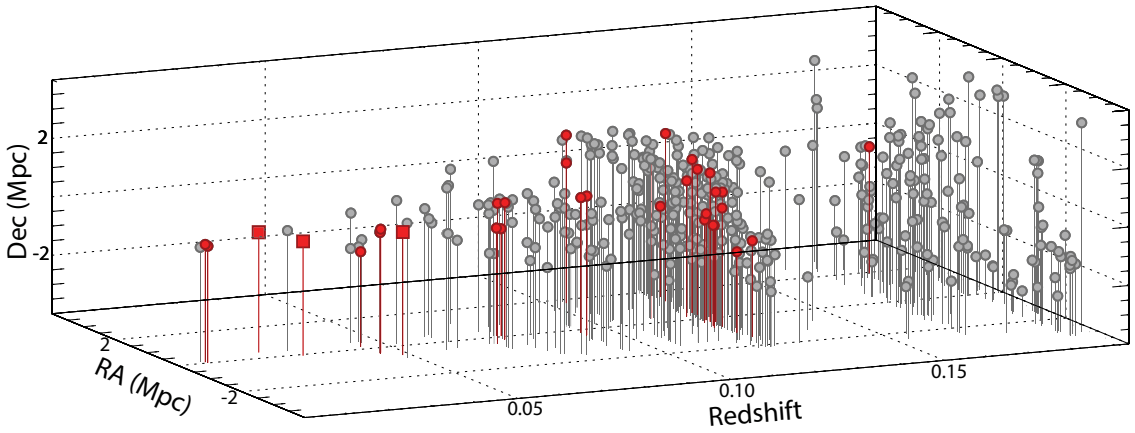


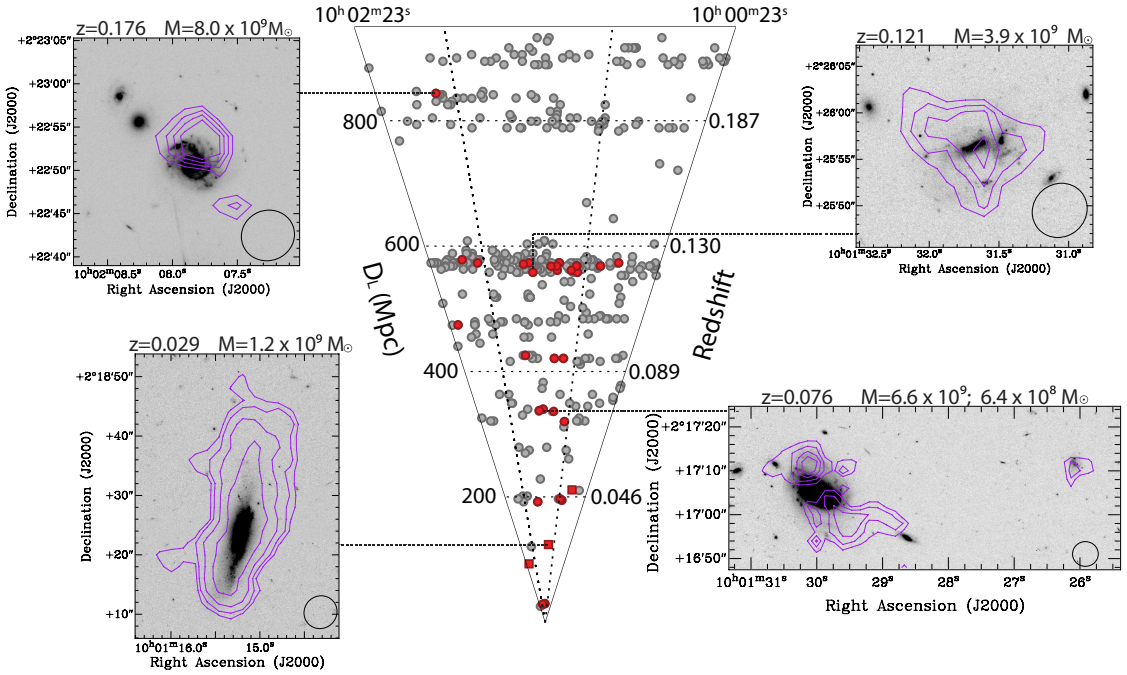
Synthesized beam

Effect of RFI is limited because of long baselines









33 detections

CONCLUSIONS (from PILOT)

A full EVLA HI Deep Field is feasible

We have 33 detections over entire redshift range
Detections follow the large scale structure as defined optically
Can study the morphology and kinematics out to z = 0.45

RFI is a challenge

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

Data volume is a challenge

but doable

Full survey has started

a few weeks late: this is why Jacqueline is not here...