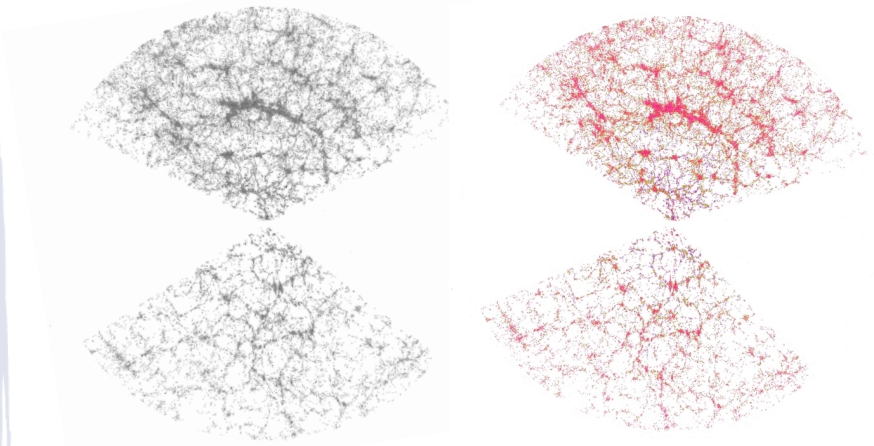
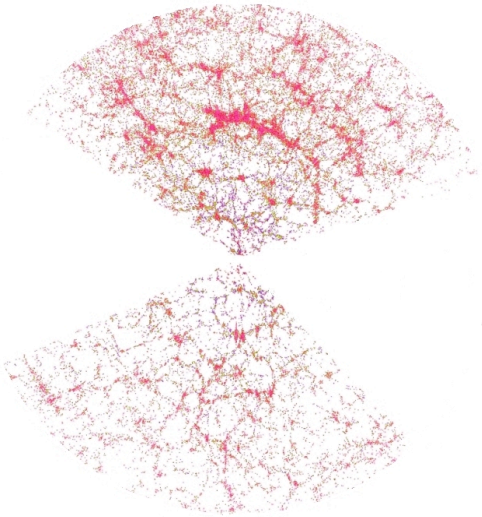
Nearly Cosmic Variance Limited BAO: 21cm / Optical/IR CRT & BigBOSS



fCPA retreat
4/23/10

Albert Stebbins
FNAL

LSS in Optical / IR



multi-band: COLOR - get galaxy types

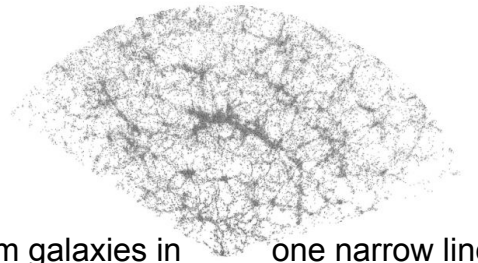
+ spectroscopic survey

LSS in 21cm

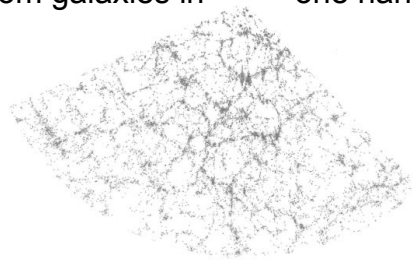
All-In-One

photometry and

spectroscopy!



all emission from galaxies in one narrow line emission

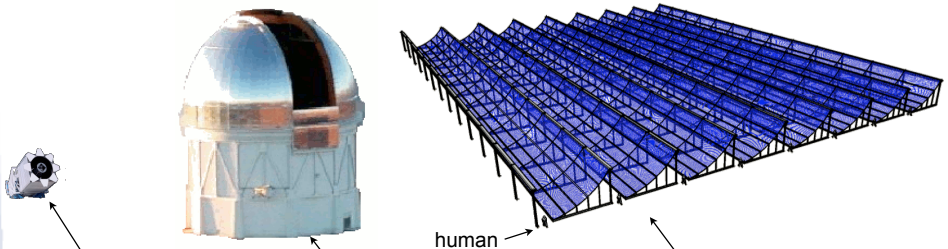


no colors - just redshifts: GRAYSCALE

$\theta \sim \lambda / D$

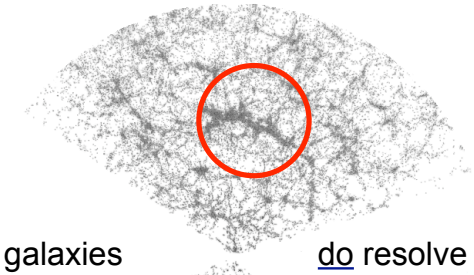
Angular Resolution is more challenging for 21cm than for optical / IR because of diffraction limit.

- Need 100m telescope for only 10' resolution!
- Fortunately cost per unit area is small.



SDSS 2.5 m DES 4 m (Blanco) CRT 100 m

INTENSITY MAPPING



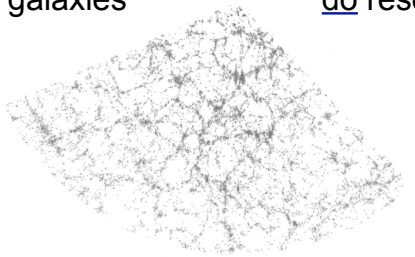
do not resolve galaxies

do resolve LSS / BAO

Peterson *et al* 2006

Wang *et al* 2006

Seo et al. 2010.



Expensive to resolve individual galaxies (e.g. SKA)

instead only resolve what is needed for BAO features!

INTENSITY MAPPING

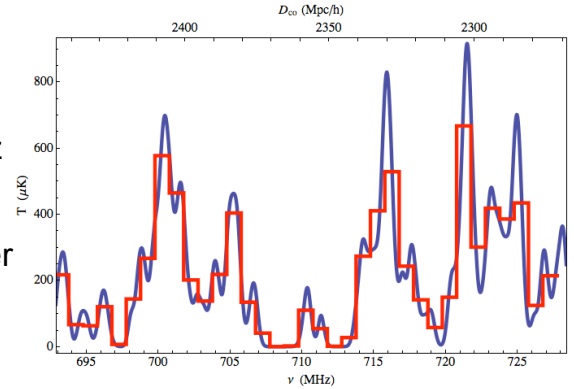
DEEP2

Δν=1 MHz

Δθ=10’

Tully-Fisher

$M_{HI} \propto L_B$

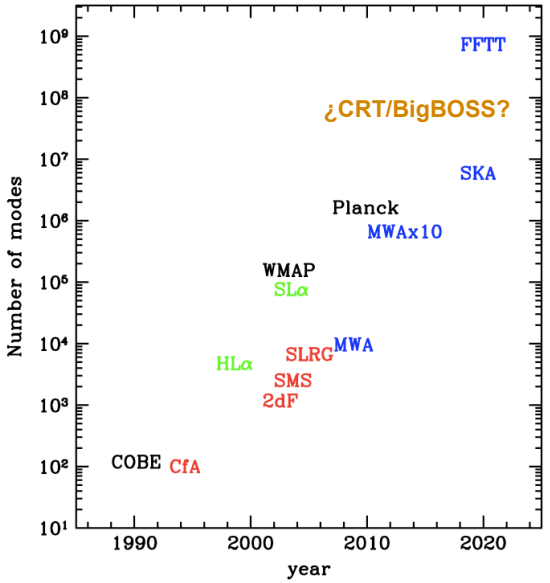


CRT

We can <u>nearly</u> resolve galaxies in redshift space.

COSMIC CARTOGRAPHY

Sensitivity ~ 1/√(# of modes)



Tegmark Zaldarriaga 2008

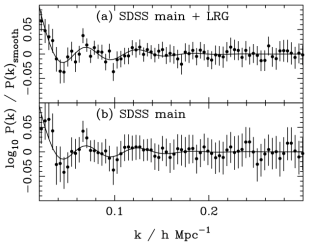
Or course both quality and quantity matters!

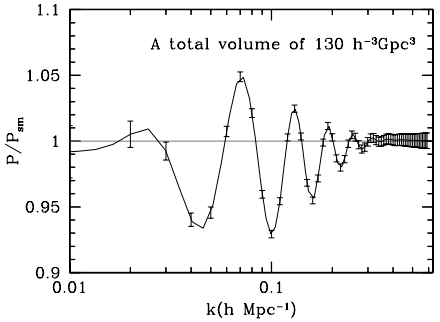
Understanding systematic errors will be an essential part of the CRT program.

This project would allow FNAL to get in on the "ground floor" to the "era of 21cm cosmology".

Baryon Acoustic Oscillations

BigBOSS-N	$0.2<z<3.5$	14,000 deg^2
BigBOSS-N+S	$0.2<z<3.5$	24,000 deg^2
CRT	$0.5<z<2.0$	30,000 deg^2





Big-BOSS

Multiobject Spectrograph on Mayall (N) / Blanco (S)

Target selection from SDSS & PannSTARRS

Risks

Big-BOSS $70M for N

Not a one stop shop / targets needed

Can we get systematics that small! (bias / z-space distortions)

CRT $20M+site+operations

No one have ever done this before! (well sort of)

Foreground subtraction! (this shouldn't be a problem)

Calibration (telescope stability)

RFI (good site)

Has Anyone Done This Before?

A positive signal was found in cross-correlation between HIPASS intensity map and 2df galaxy survey (Pen et al. 2008)

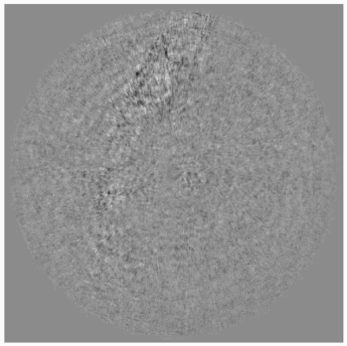


Figure 1. The HIPASS data cube $R < 127h^{-1}$ Mpc, projected in a cartesian coordinate system towards the south pole.

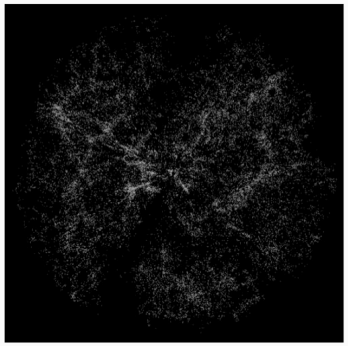


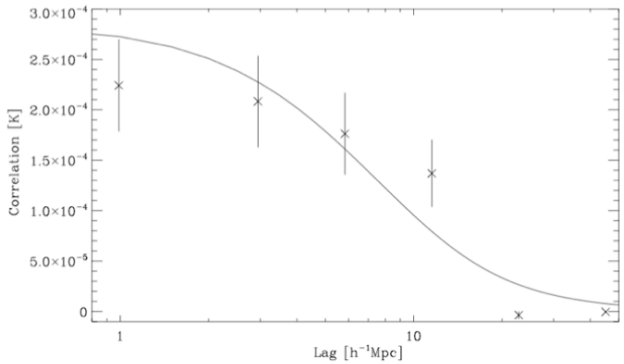
Figure 2. The 6dFGS catalog for $R < 127h^{-1}$ Mpc, also projected towards the south pole. The missing wedges are the galactic plane.

For DE one would need auto-correlation!

Has Anyone Done This Before?

HI & Optical cross-correlation at z~0.8

- Shows correlation between hydrogen and Deep2 optical galaxy surveys to 10 Mpc



Chang, Pen, Peterson, Bandura, submitted