Medium-and ultra-deep HI surveys with SKA

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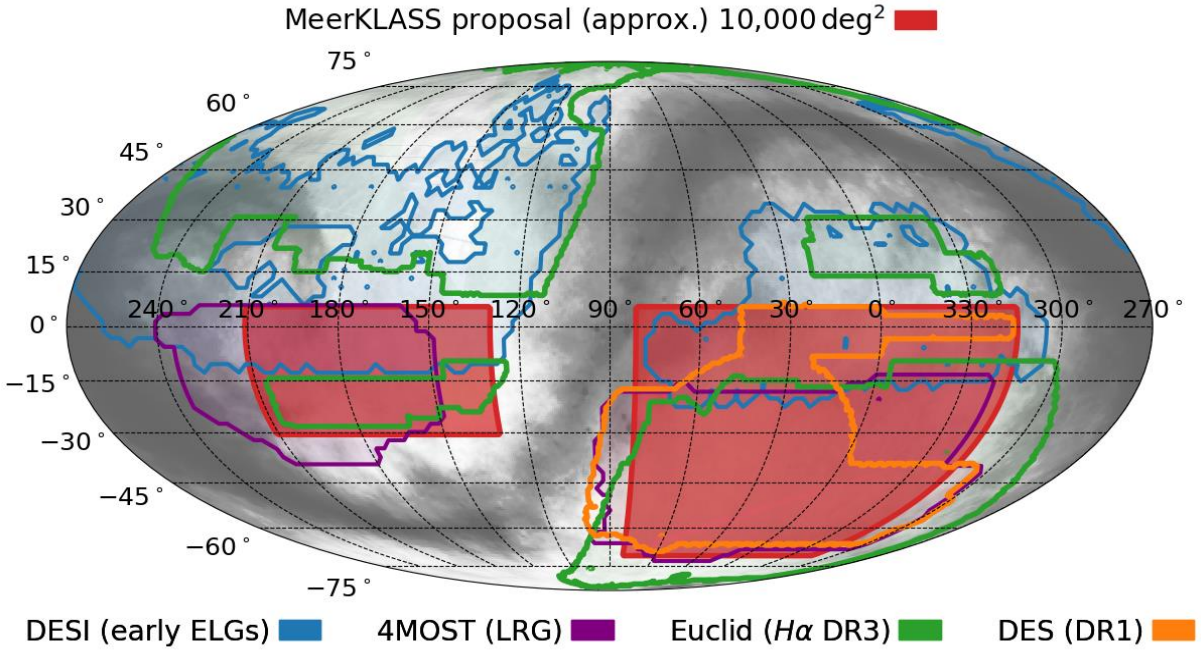
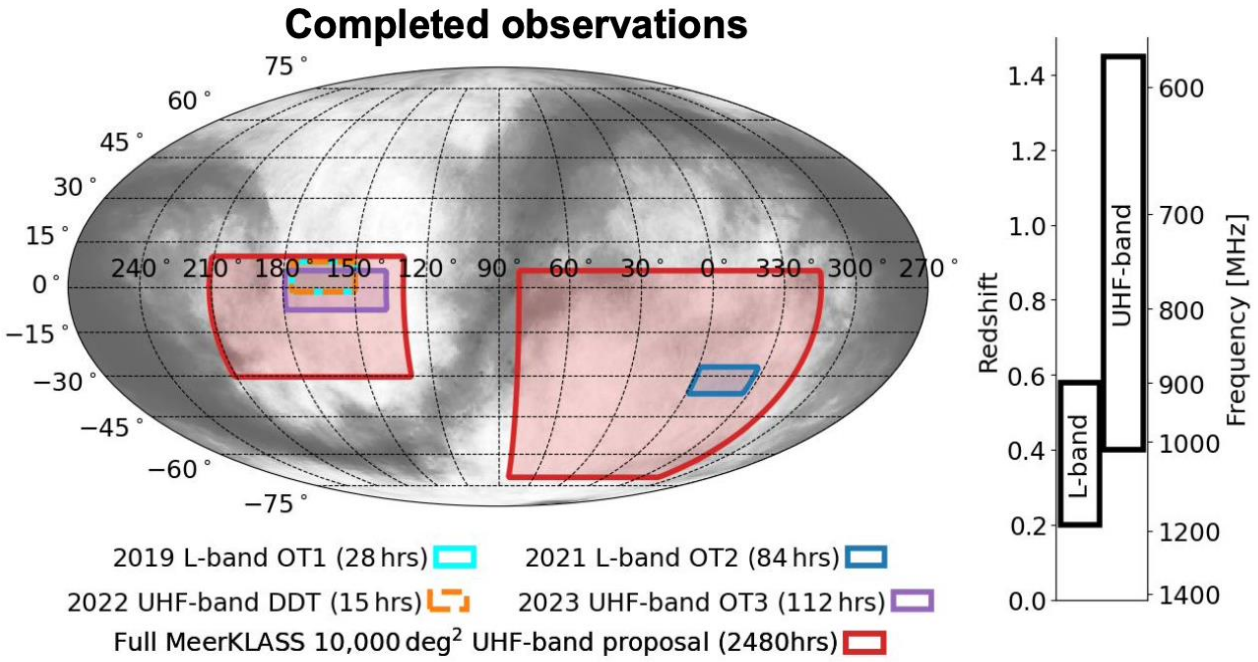
Sep. 30, 2025

MeerKLASS: MeerKAT Large Area Synoptic Survey

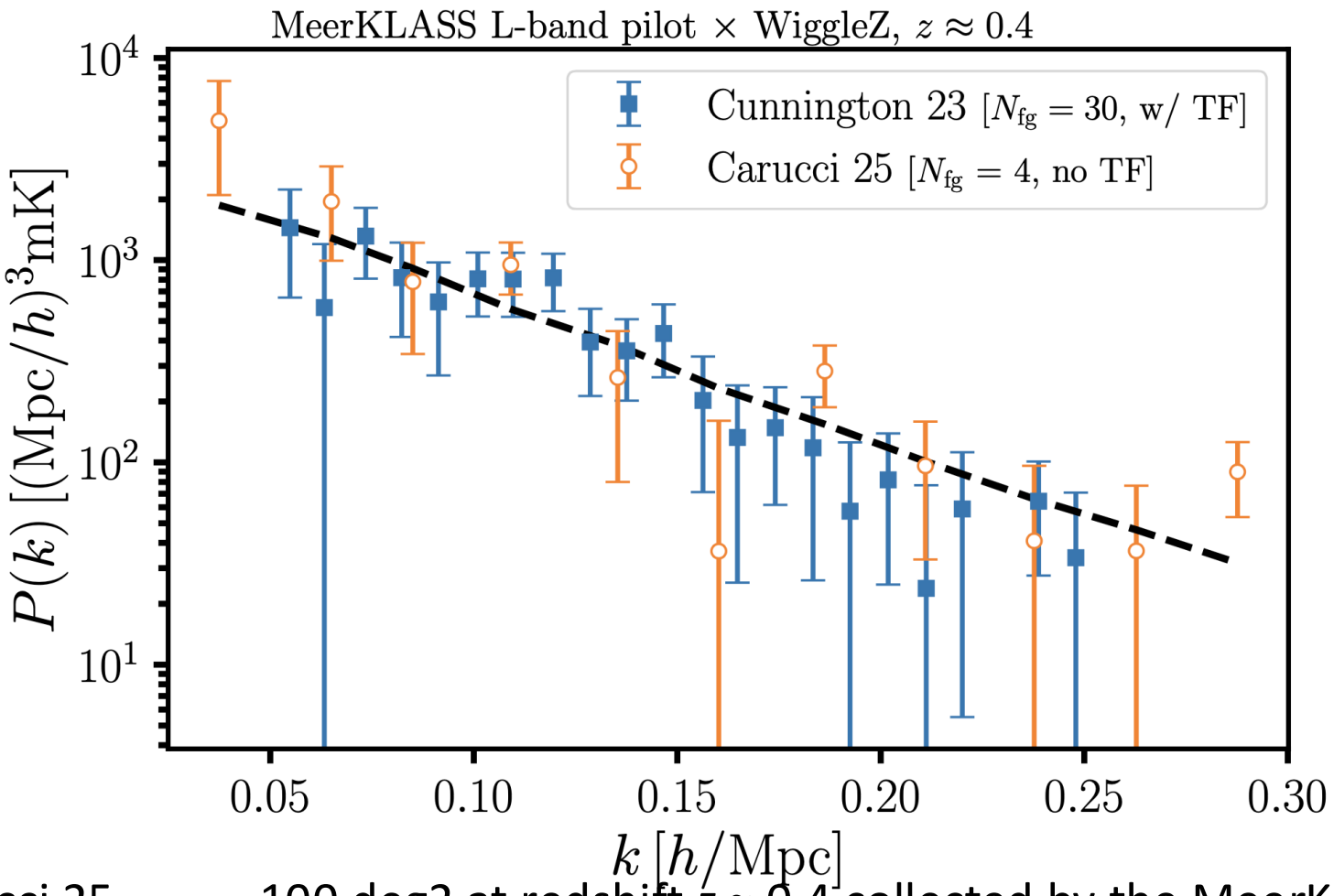
- Aim: Cosmology (HI intensity mapping) but commensal with lots of other science (continuum survey)
- Covering L-band (900-1670MHz, z<0.57) and UHF band (580-1015MHz, z ~ 0.4-1.45)
- Focus on sky patches with multi-wavelength data for cross-correlation
- Goal: 2,500 hours over 10,000 deg2 within next 4 years
- The leading radio Cosmology survey in preparation towards SKA1-MID
- International collaboration

S.Cunnington



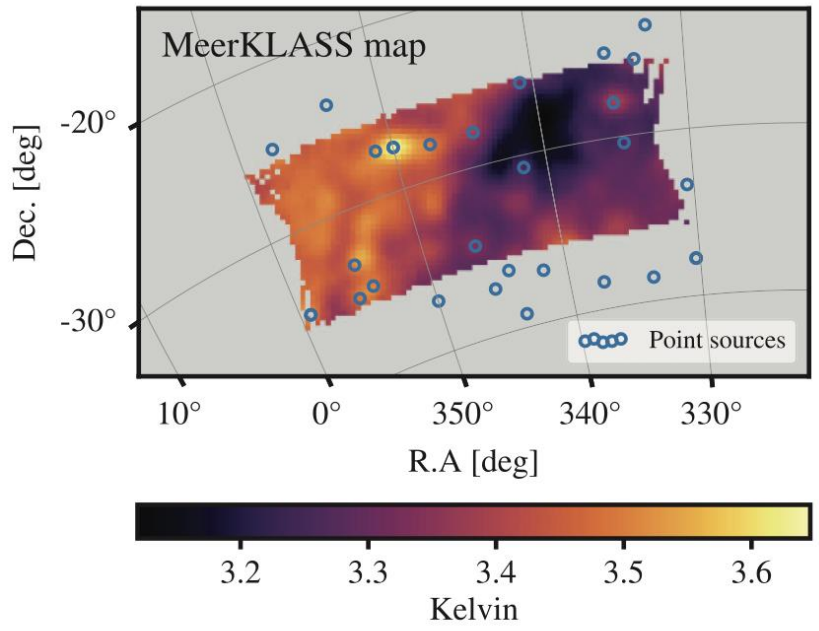


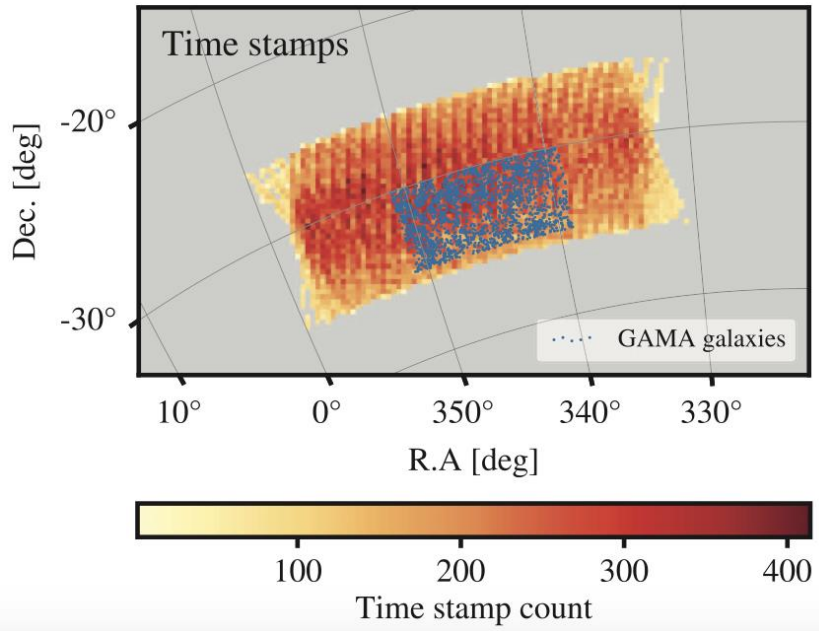
MeerKLASS studies

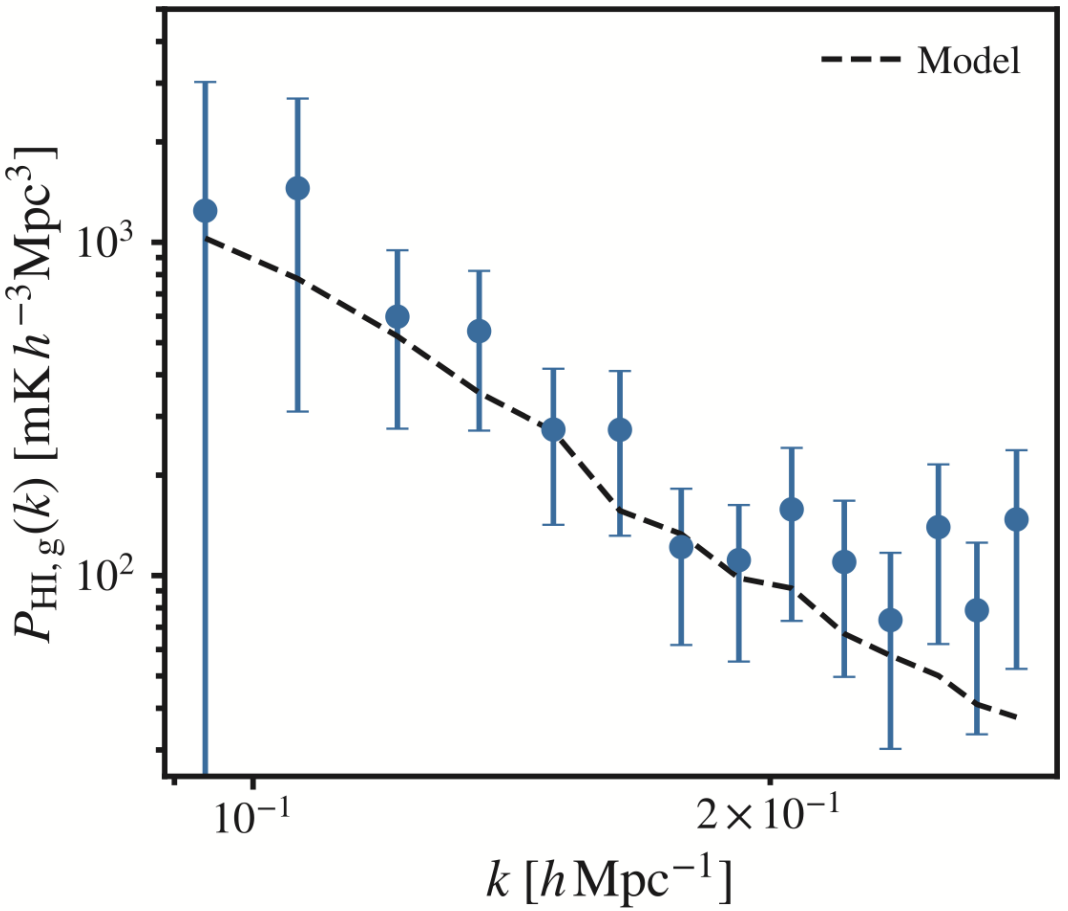


Carucci 25 100 deg2 at redshift $z \approx 0.4$ collected by the MeerKAT, with a combined 10.5-hour observation

MeerKLASS studies







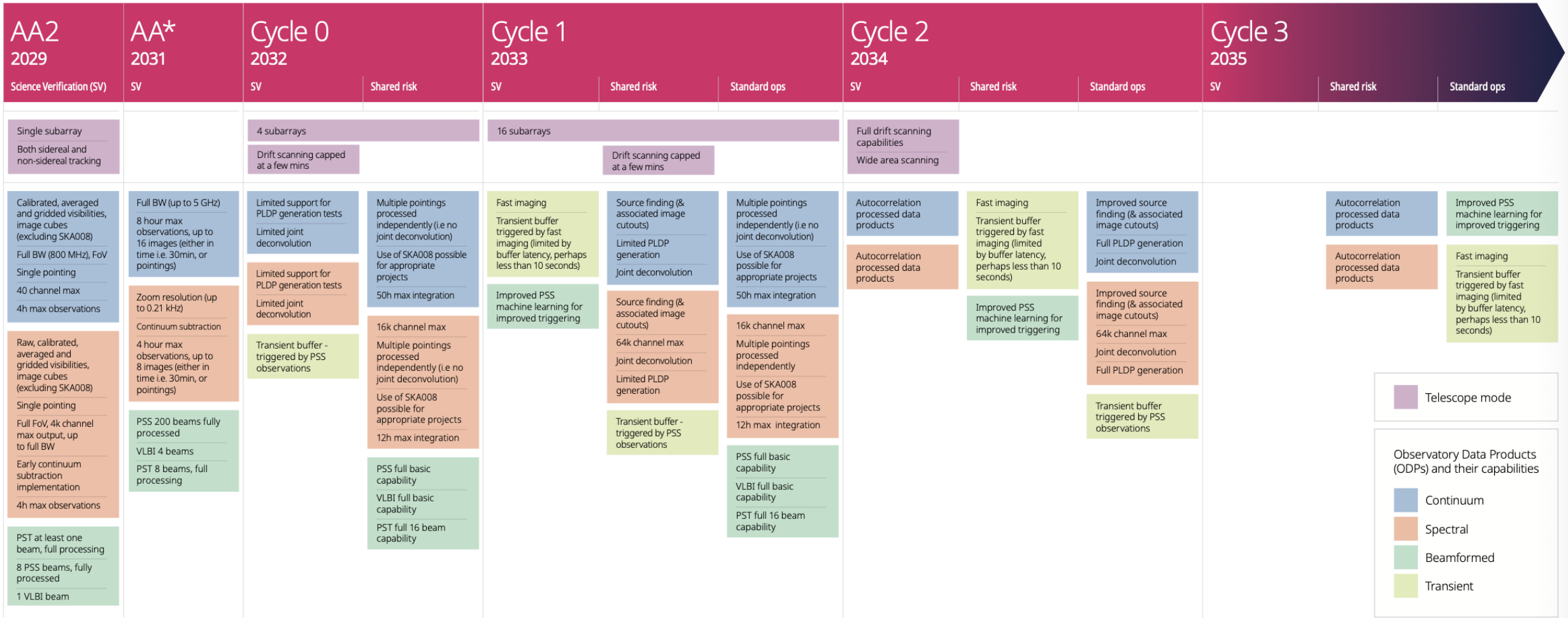
MeerKLASS Collaboration 2025

41 repeated scans over 236 deg2,

62 h of observation for each of the 64 dishes before flagging.

$0.39 < z < 0.46$ ($971\ \mathrm{MHz} < \nu < 1023\ \mathrm{MHz}$)

SKA-Mid: Delivery of observing modes and ODPs to the astronomy community



Ska-mid

Subarray configuration	Number ska Antennas	Number of meerkat Antennas
AA0.5	4	0
AA1	8	0
AA2	64	0
AA*/AA4(13.5-m only)	0	64
AA*	80	64
AA4	133	64

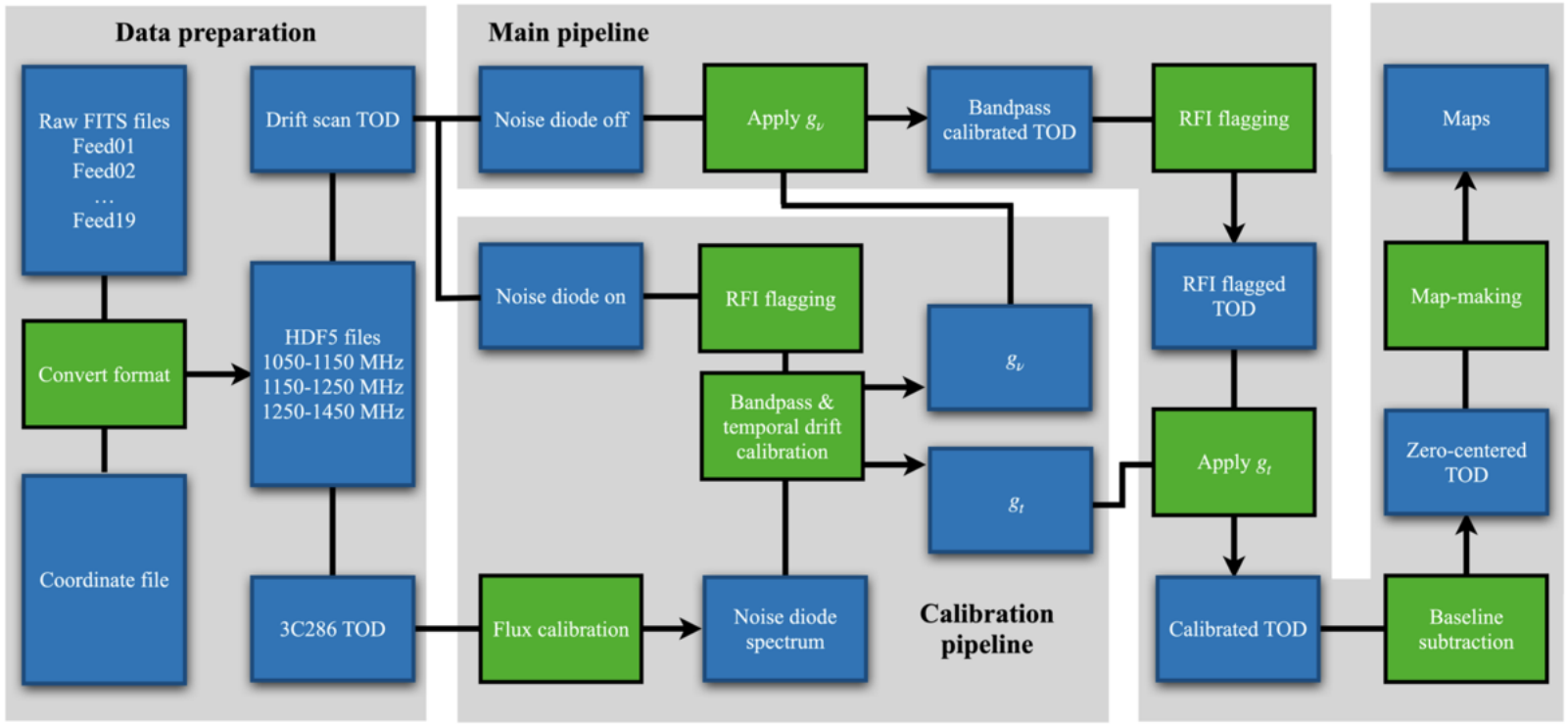
FATHOMERS

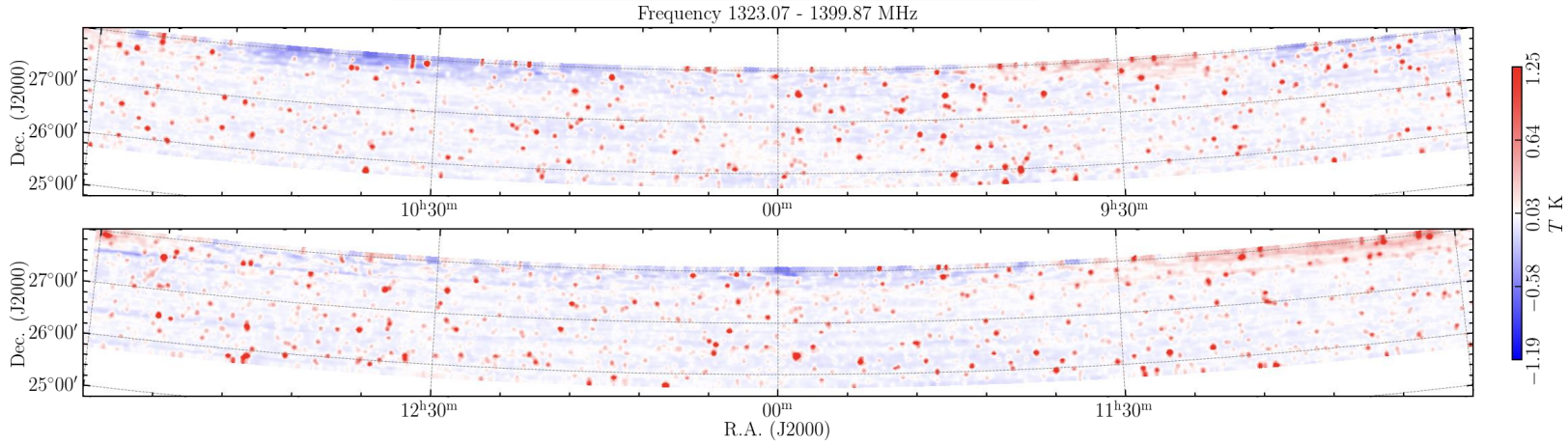
FAst neuTral HydrOgen intensity Mapping ExpeRiment
(FATHOMER 宇宙溯源人)

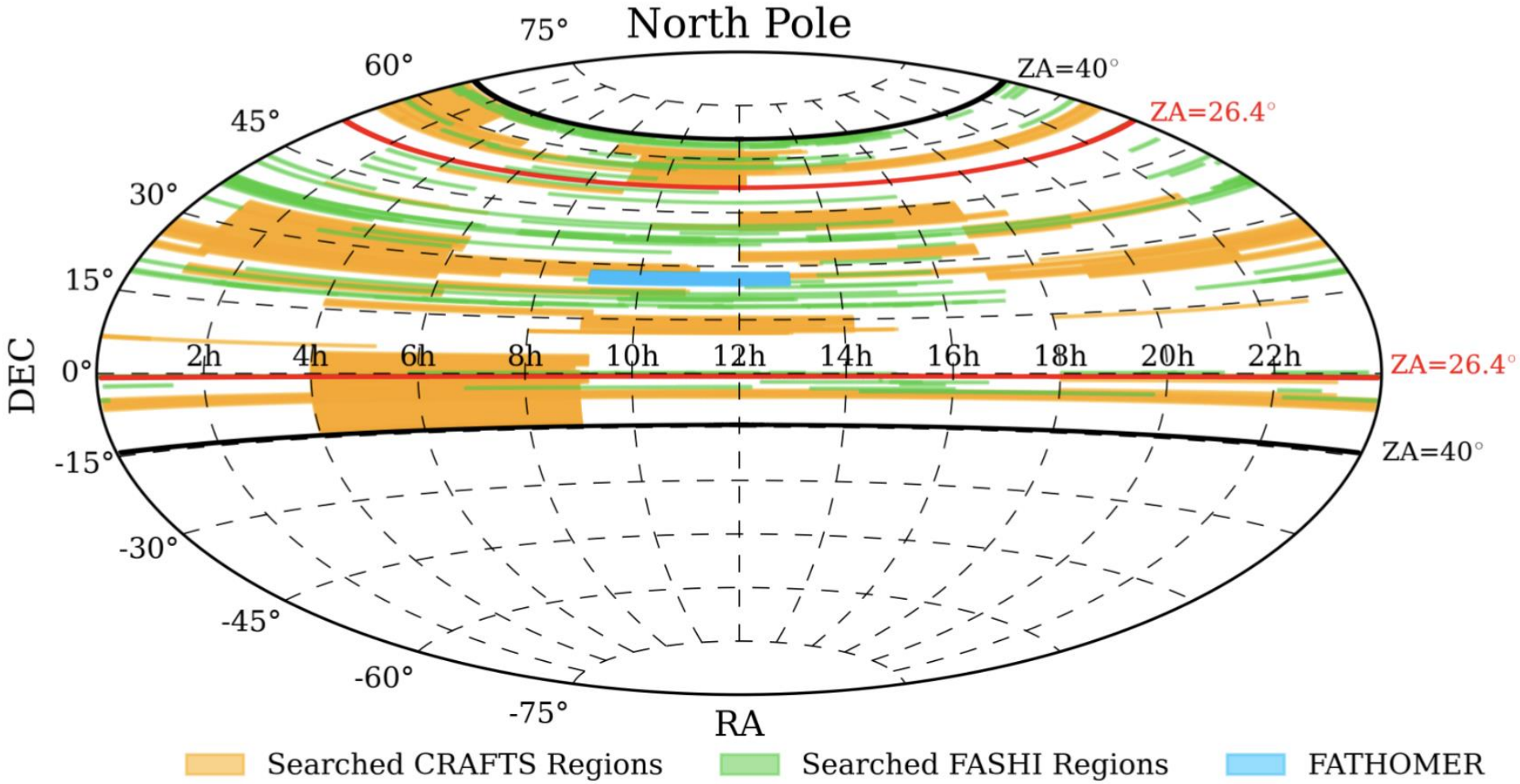
Li Y.C., Wang Y.G. et al.
2023, ApJ, 954, 139.
liyichao@mail.neu.edu.cn

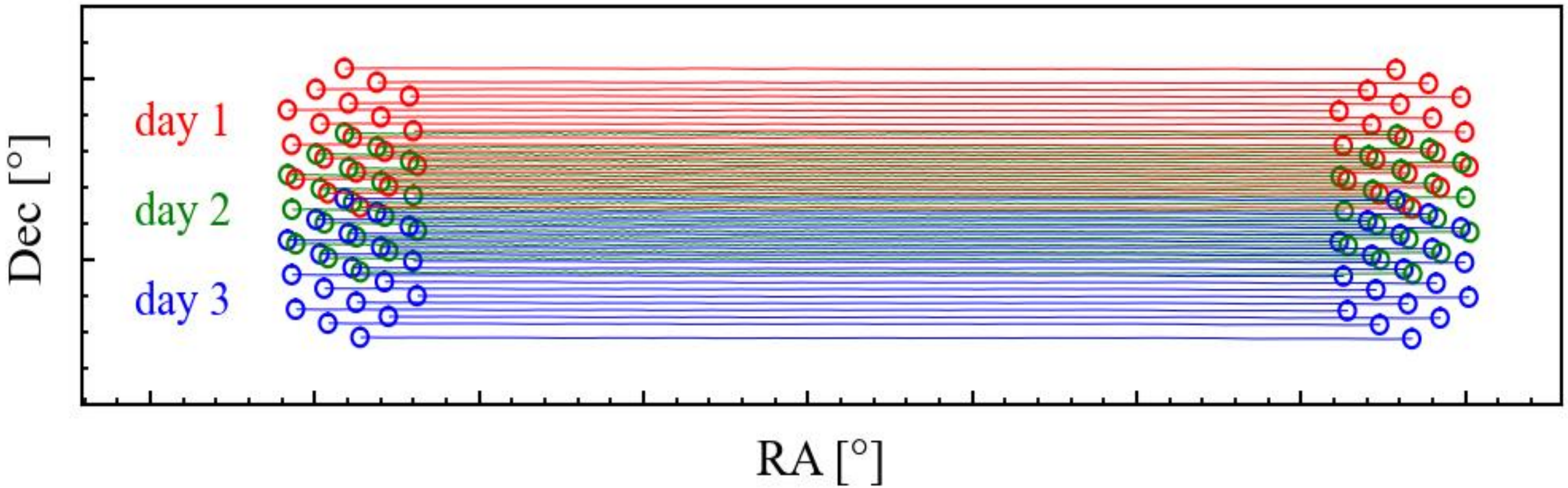
fpipe

Li, Wang et al. 2023, ApJ, 954, 139





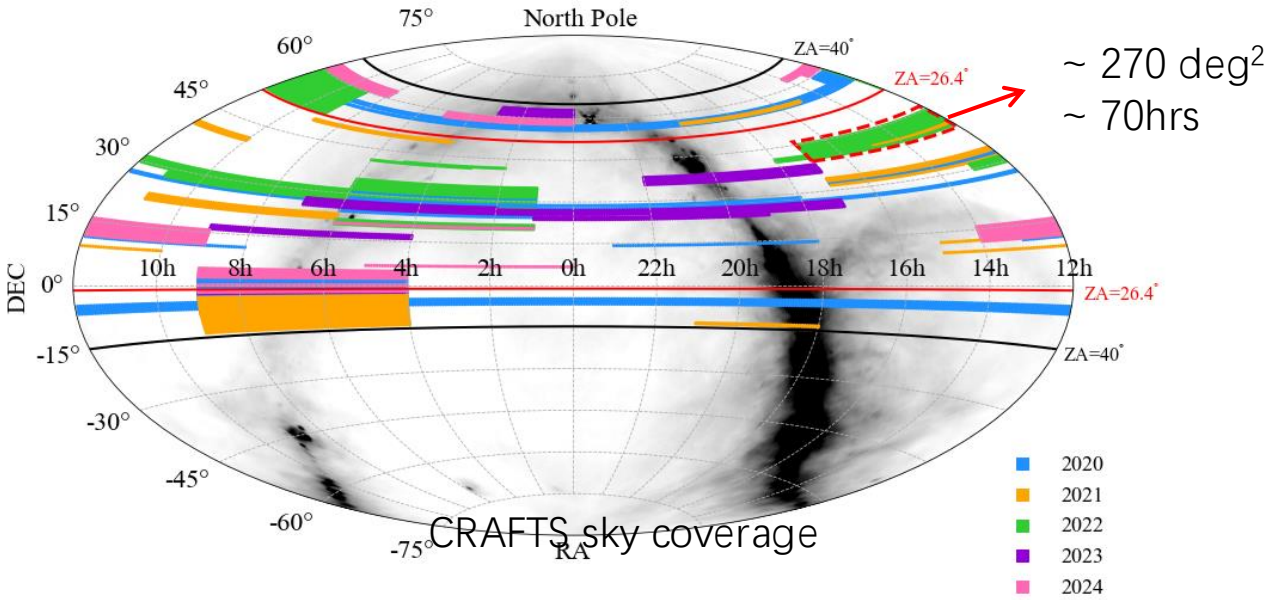

North Pole
75°
60°
45°
30°
15°
0°
-15°
-30°
-45°
-60°
-75°
DEC
2h
4h
6h
8h
10h
12h
14h
16h
18h
20h
22h
RA
ZA=40°
ZA=26.4°
ZA=26.4°
ZA=40°
Searched CRAFTS Regions
Searched FASHI Regions
FATHOMER


day 1
day 2
day 3
Dec [°]
RA [°]

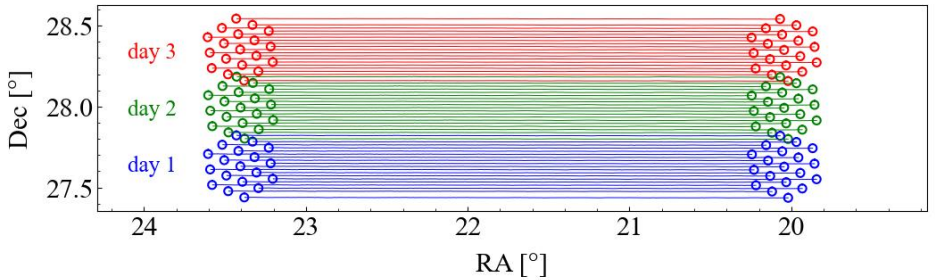
FAST large scale surveys

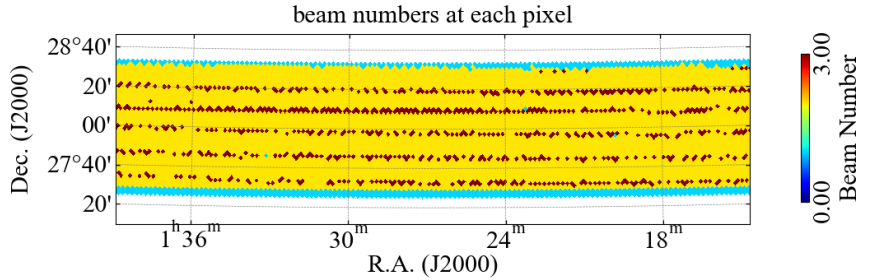
- **CRAFTS** (The **C**ommensal **R**adio **A**stronomy **FAST** **S**urvey)

- calibration mode: high-cadence noise(~1K) injection mode: T_{inj} ~ 196.608μs



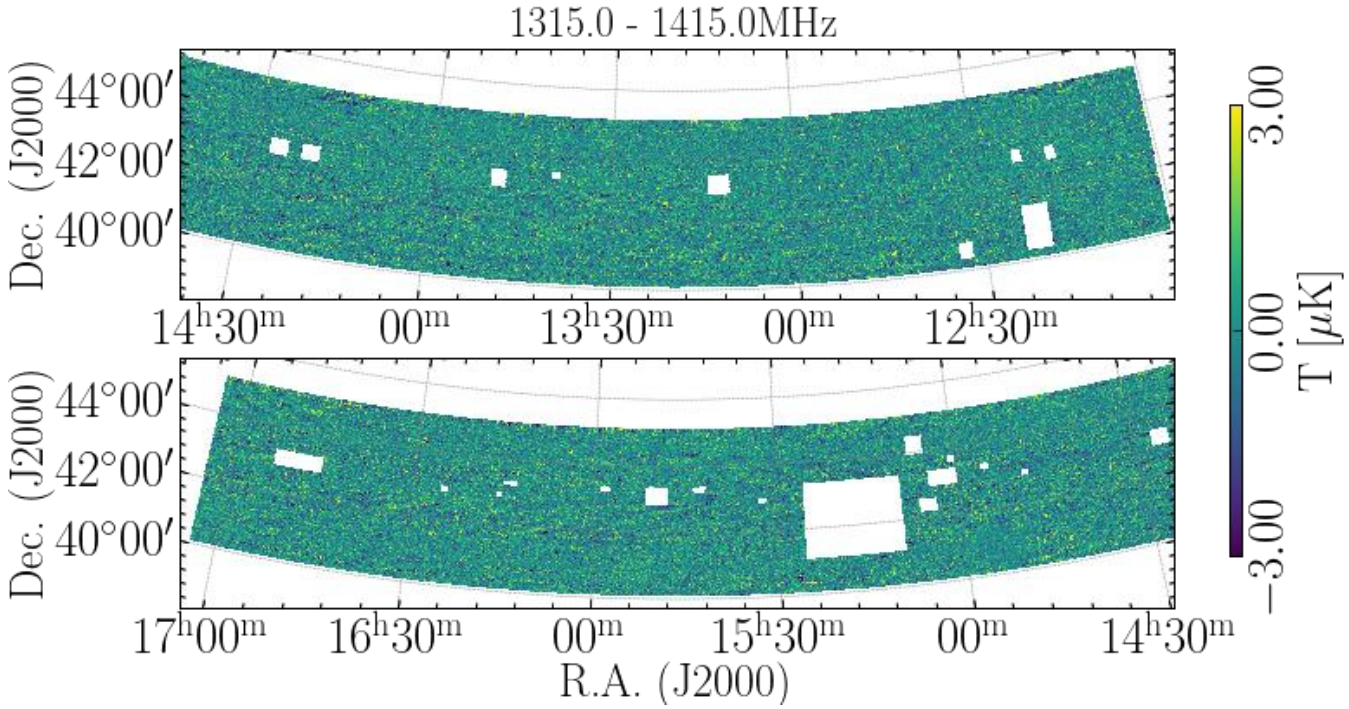
CRAFTS sky coverage



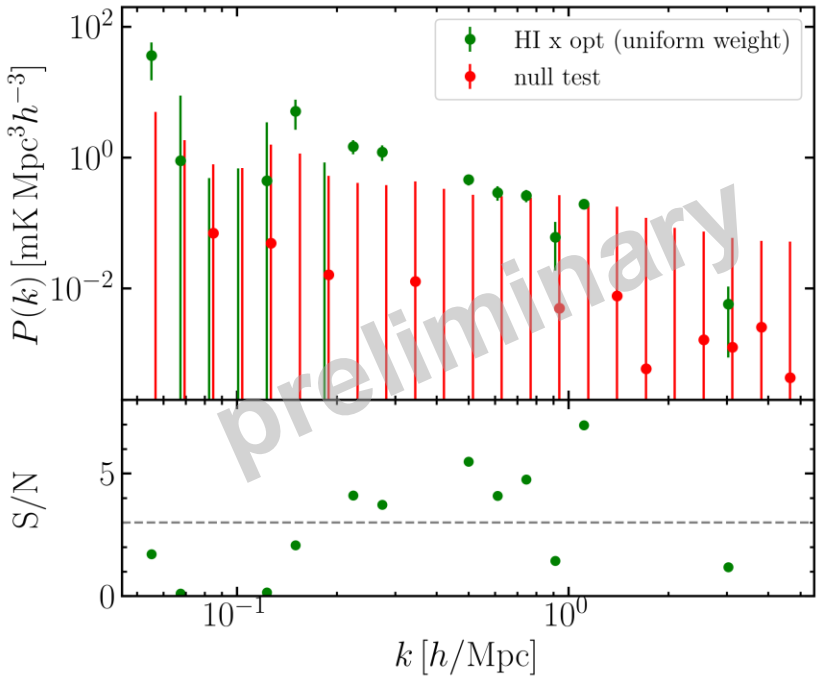


drift scan with L-band 19-beam receiver

power spectrum estimation



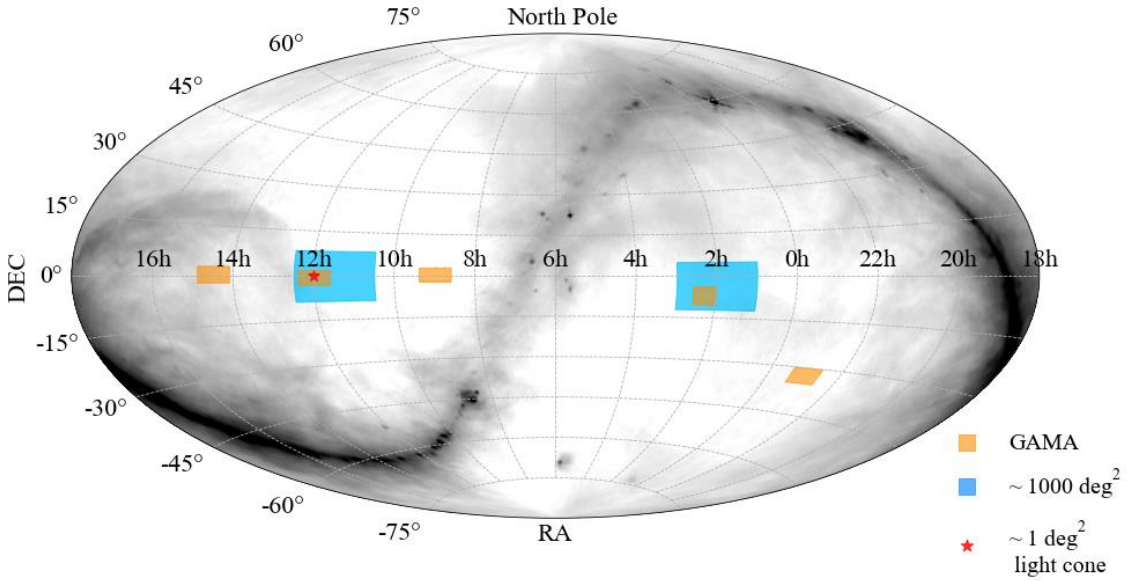
30 foreground modes removed map



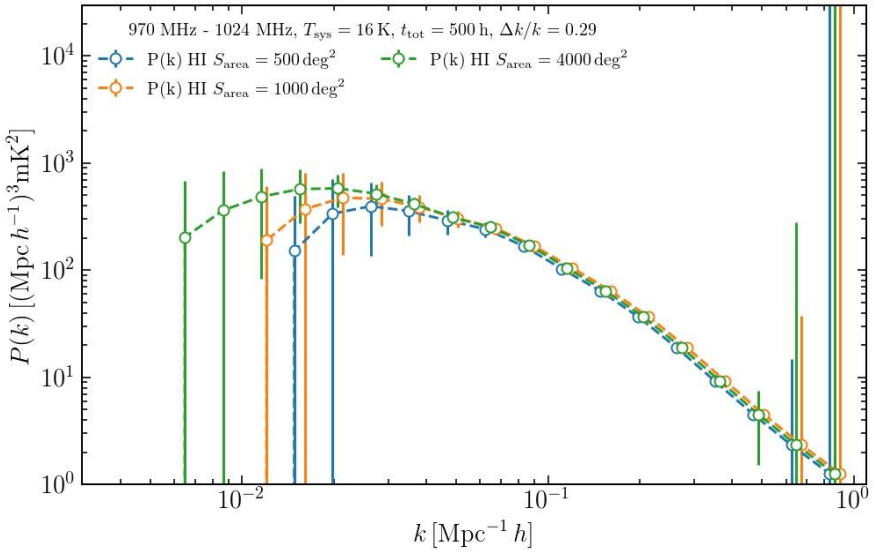
HI x SDSS power spectrum

➢ HI medium-deep survey

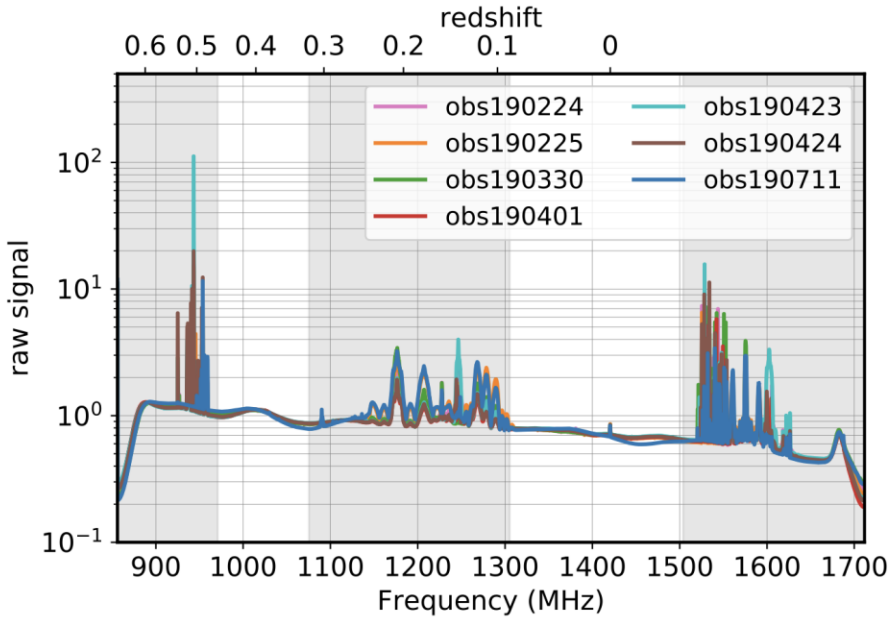
- 1000 deg², overlaped with FAST。
- For the first step, forced on ~1130MHz for the second step, moving to the high redshift



500hours，OTF

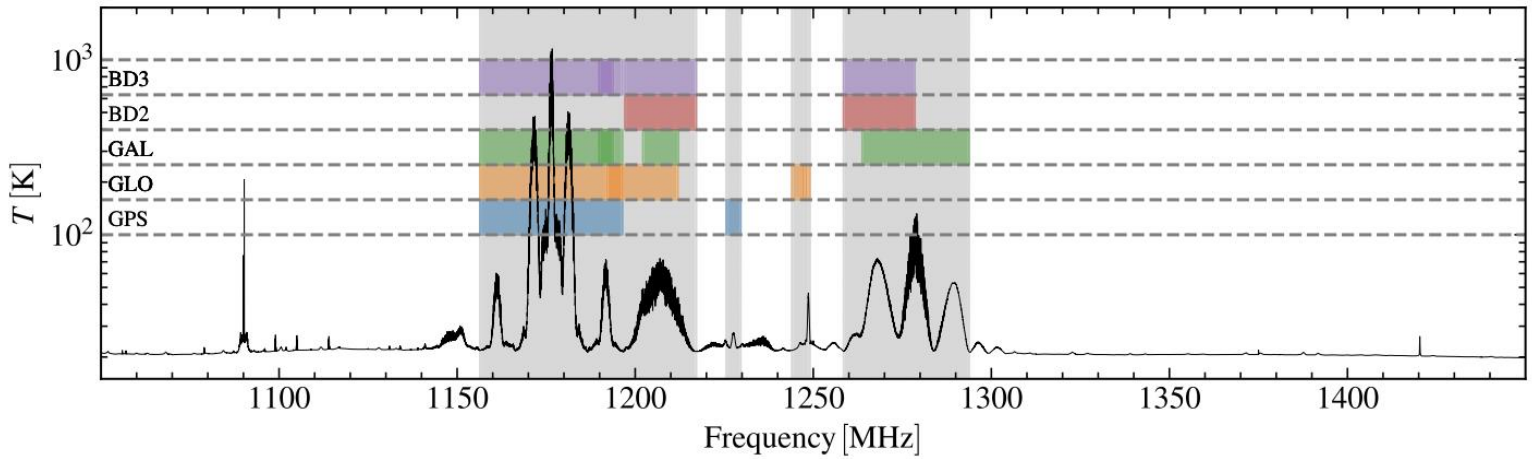


Telescope	Band	Frequency Range (MHz)	Available Bandwidth (MHz)	Notes (MHz)
SKA1-Low	N/A	50 - 350	300	(1)
SKA1-Mid	1	350 - 1050	700	(1)
	2	950 - 1760	810	(1)
	3	1650 - 3050	1400	(2)
	4	2800 - 5180	2380	(2)
	5a	4600 - 8500	3900	(1)
	5b	8300 - 15400	2 x 2500	(1)



Wang Jingying et al. 2021

MeerKAT



Li et al. 2023

FAST

➢ HI ultra-deep survey

- 1 deg^2 region （100 hours)

Related sciences：

1. HI mass function at the low mass end、high redshift、2d power-spectrum with the Interferometry

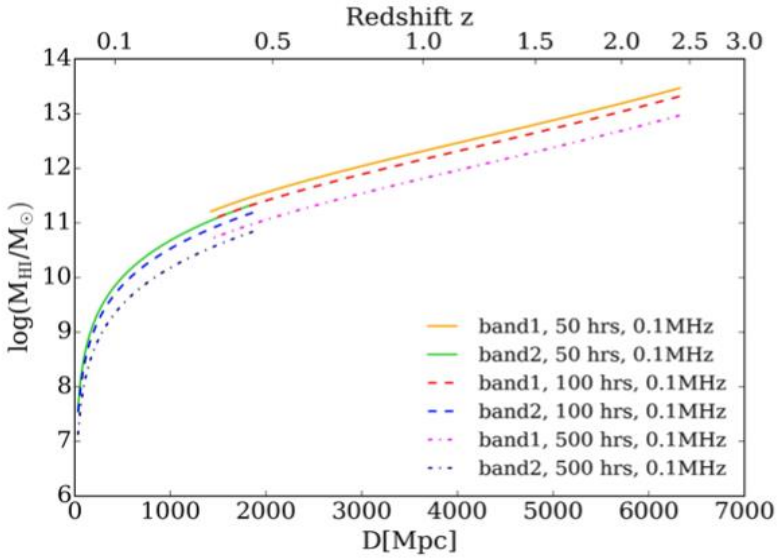
2. One-dimensional power spectrum of HI

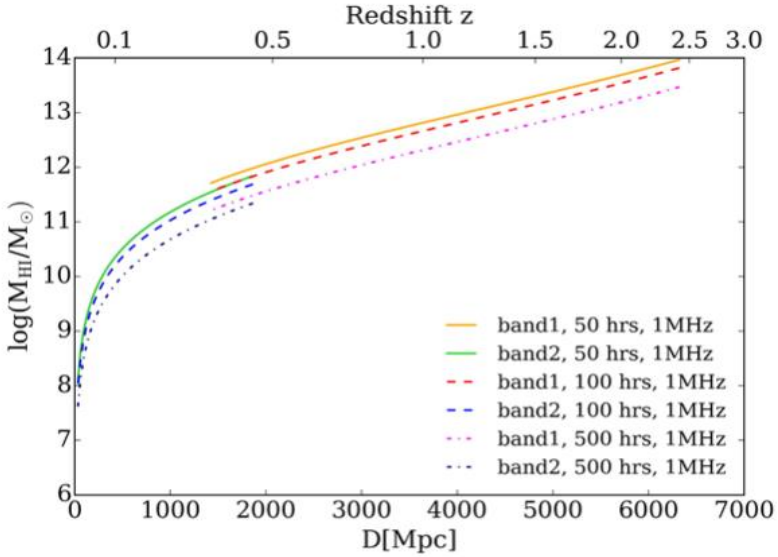
3. Dependence of HI galaxy on the environments

4. Evolution of Ω_{HI} with redshift

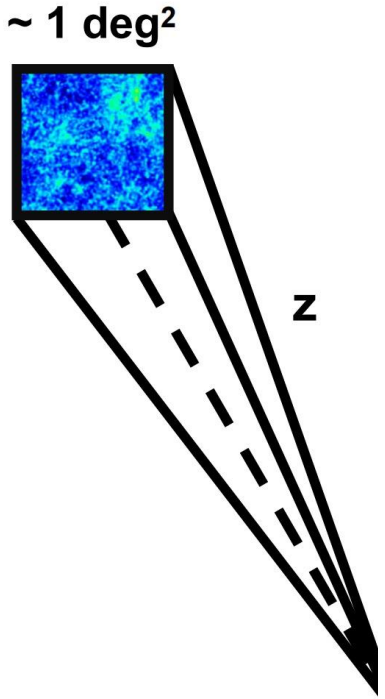
5. Redshift distortion on the small-scale

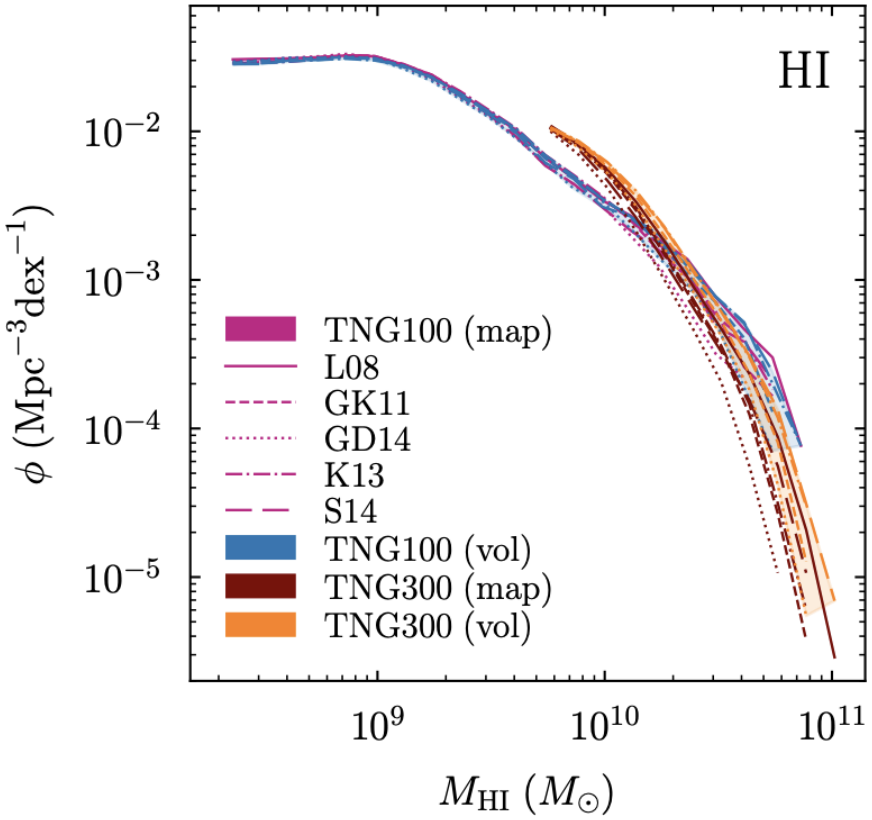
6. Other sciences

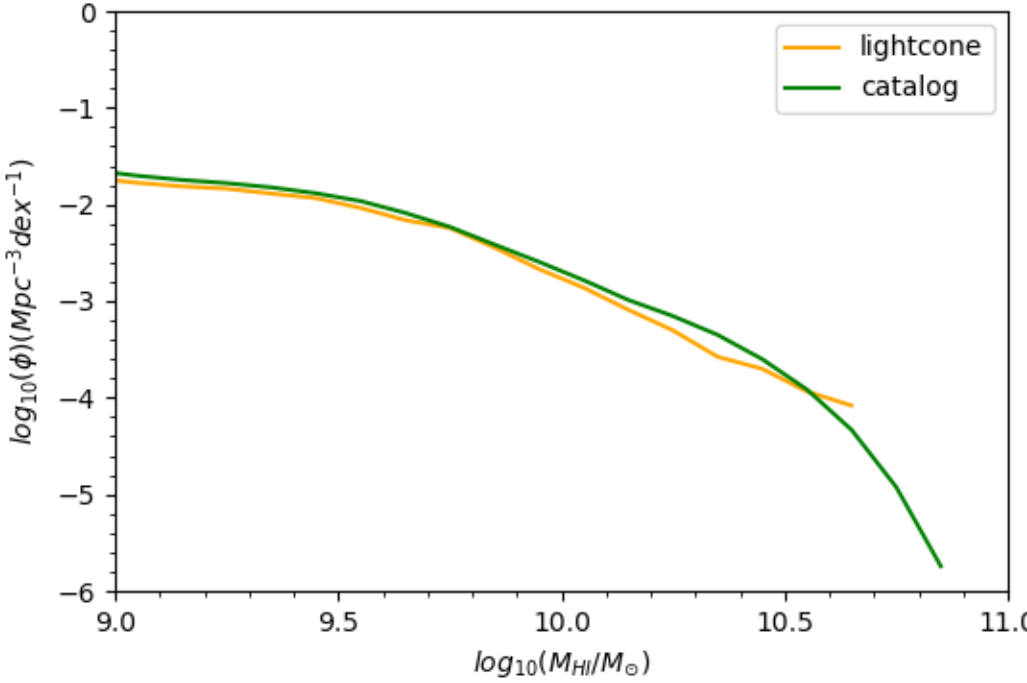




Light-cone







TNG300， length～600Mpc， the radius is 15Mpc at z=0.5

Next step

- To add the systematical error to the light-cone
- To apply the observation time of MeerKAT in2026
- For the CRAFTS survey in FAST，we will make sure the PS for the cross-correlation, even for the auto-correlation
- For the FATHOMER survey, we have obtained 60 hours for the observations this year.