



中国科学院国家天文台

NATIONAL ASTRONOMICAL OBSERVATORIES
CHINESE ACADEMY OF SCIENCES



中国科学院大学
University of Chinese Academy of Sciences



The University of Manchester

Calibration pipeline and results for HI intensity mapping with FAST

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Outline

- **HI Intensity mapping**

- **FAST & CRAFTS**

 - basic information, data, pilot survey results

- **Data processing pipeline**

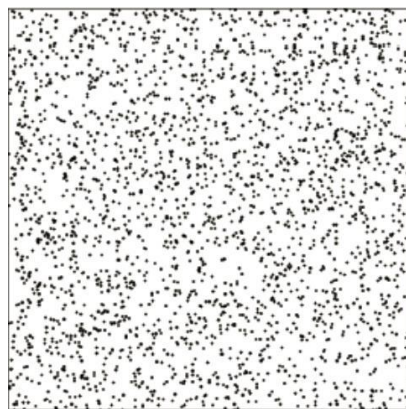
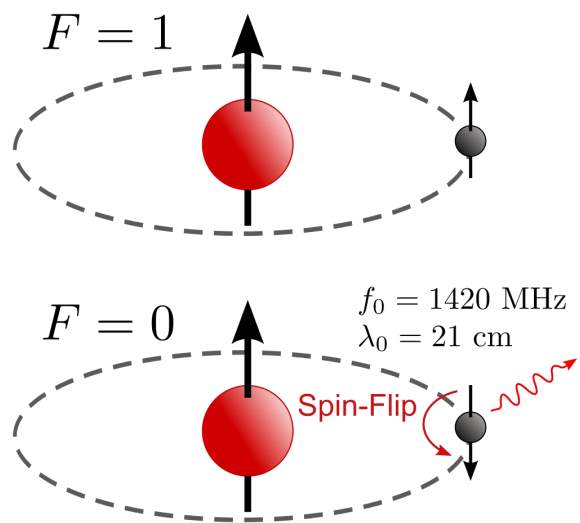
 - calibration, RFI flagging, baseline subtraction, map-making

- **Preliminary results**

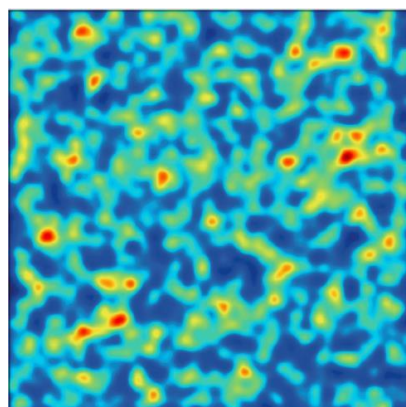
 - continuum sources, HI emission lines, foreground removal tests

- **Summary**

HI intensity mapping

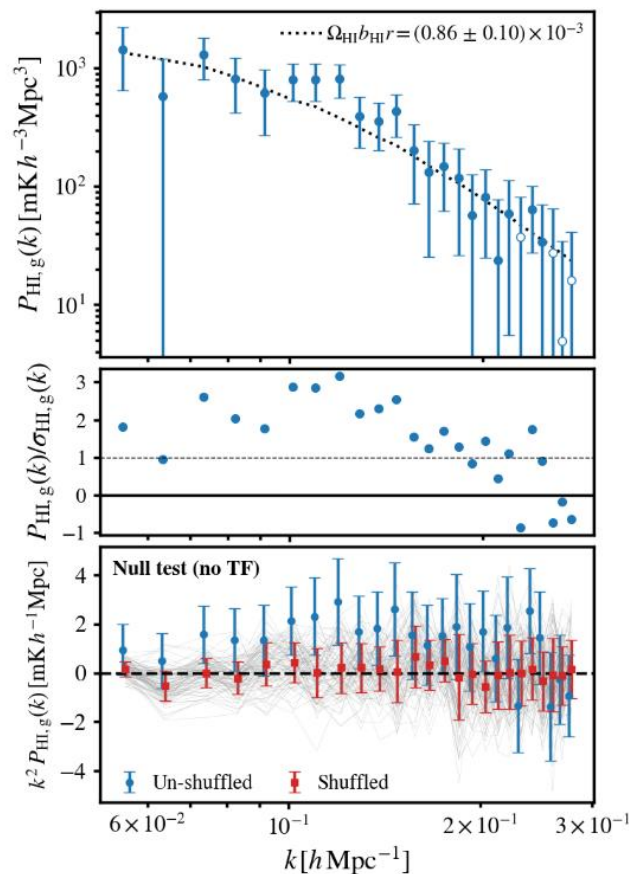


galaxies

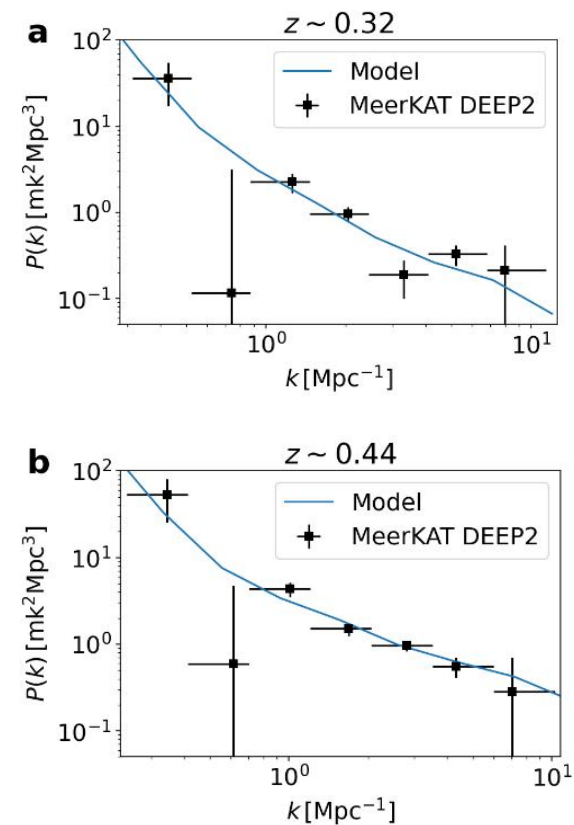


intensity map

some results from MeerKAT
single dish mode interferometric mode

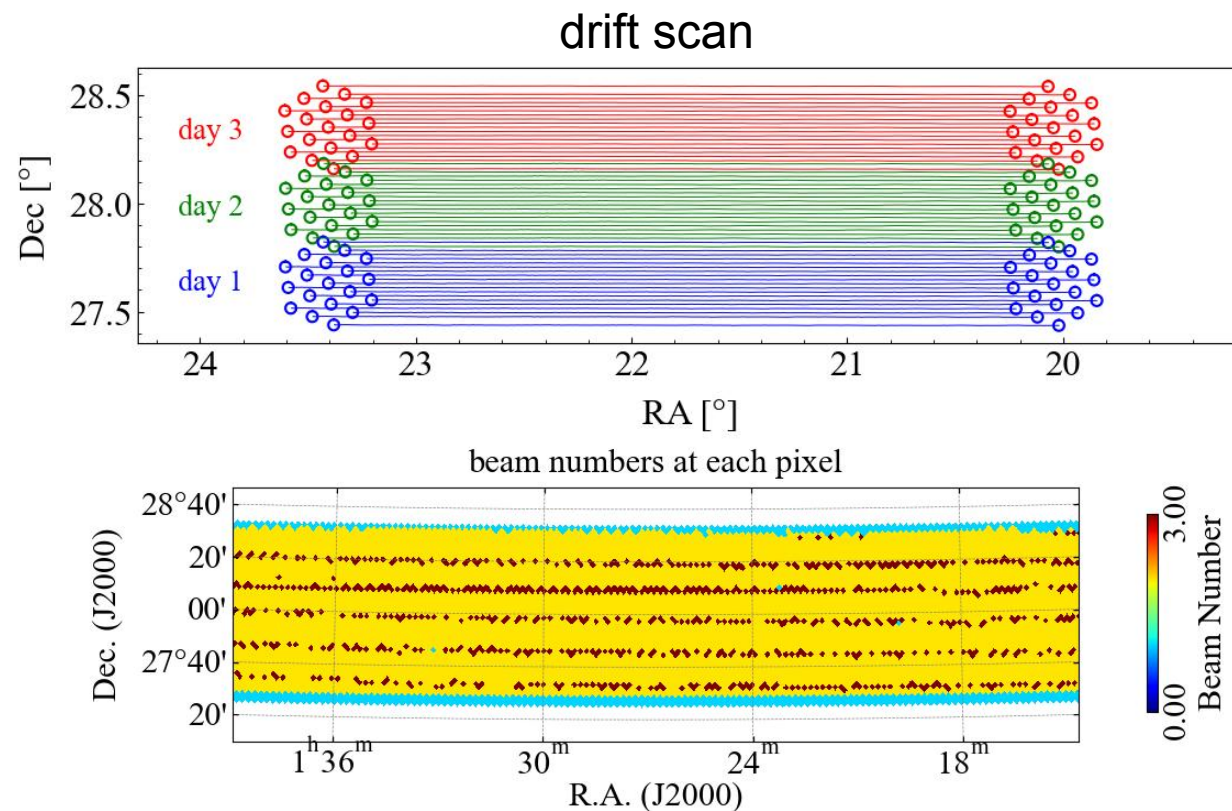


MeerKAT \times WiggleZ
 $0.4 < z < 0.459$
(Cunnington et al. 2023)



MeerKAT autoPS
(S. Paul et al. 2023)

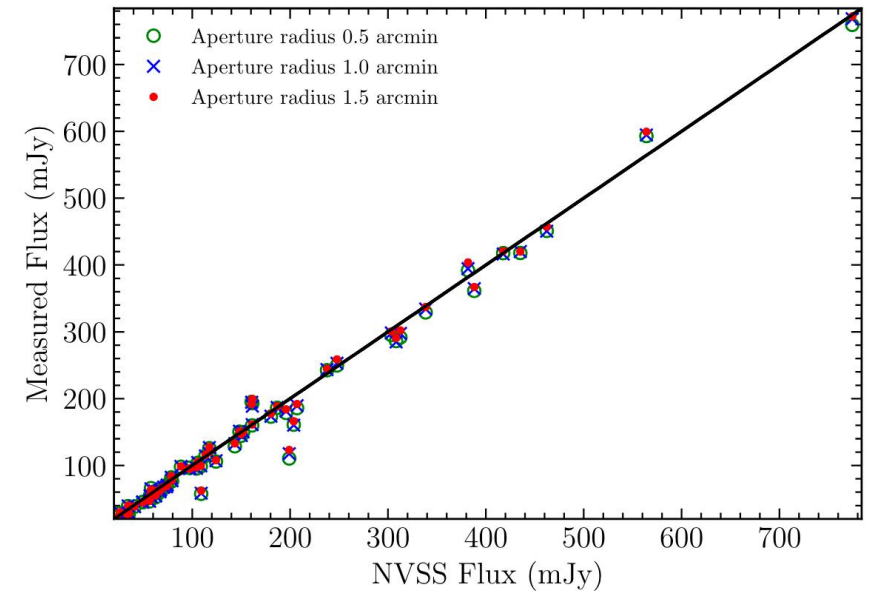
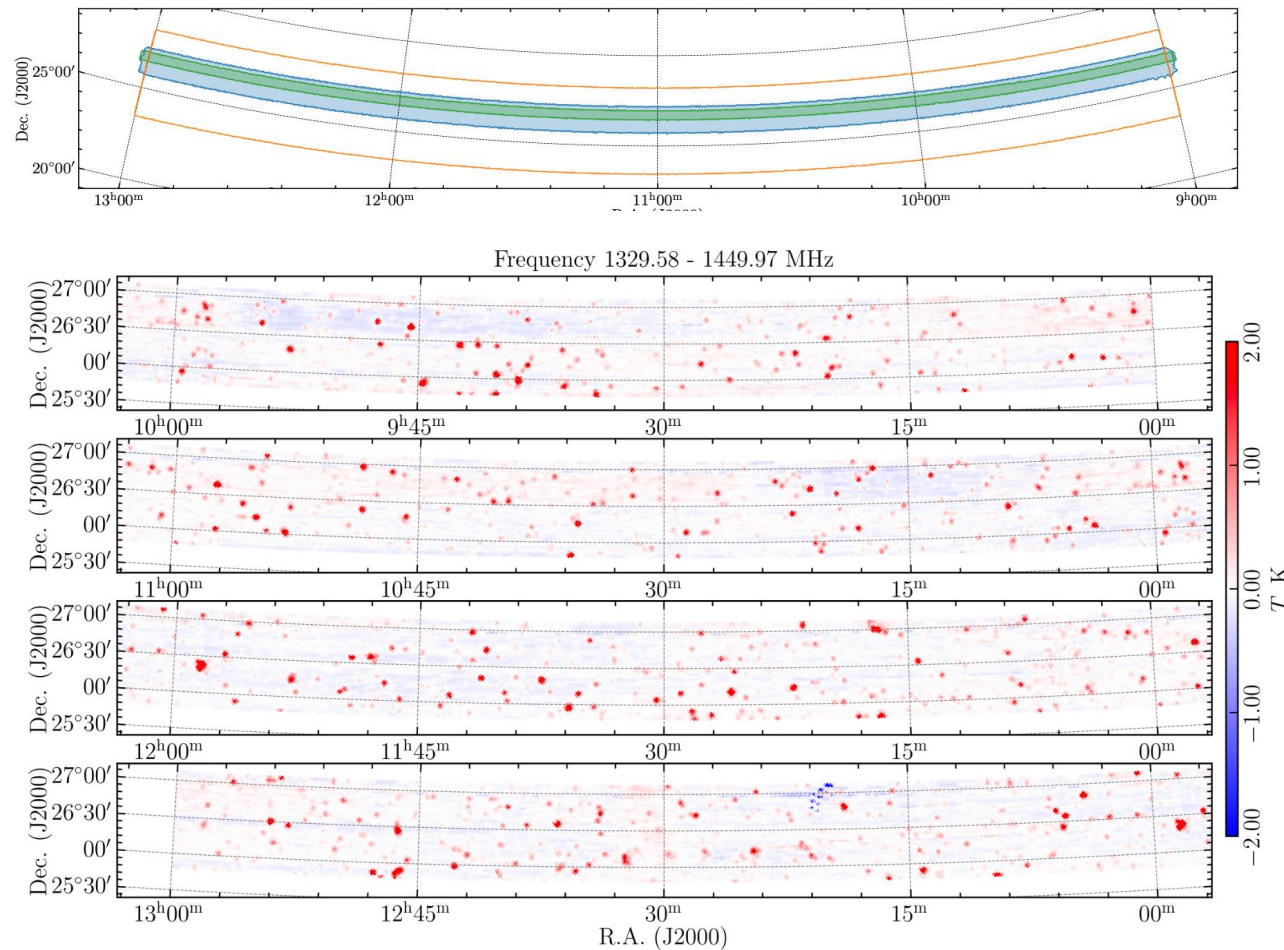
FAST



- **FAST** (Five-hundred-meter **A**pererture **S**pherical radio **T**elescope)
- Location: Guizhou, China, E 106.°86, N 25.°65
- sky coverage: -15° ~ 65°
- $D_{\text{geo}} = 500\text{m}$, $D_{\text{illu}} = 300\text{m}$, $A_{\text{eff}} \sim 50,000\text{m}^2$
- L-band(1-1.5GHz) 19-beams receiver

HIIMGS pilot survey

RA 9-13h, Dec 25.9 - 27.1d, $\sim 60\text{deg}^2$

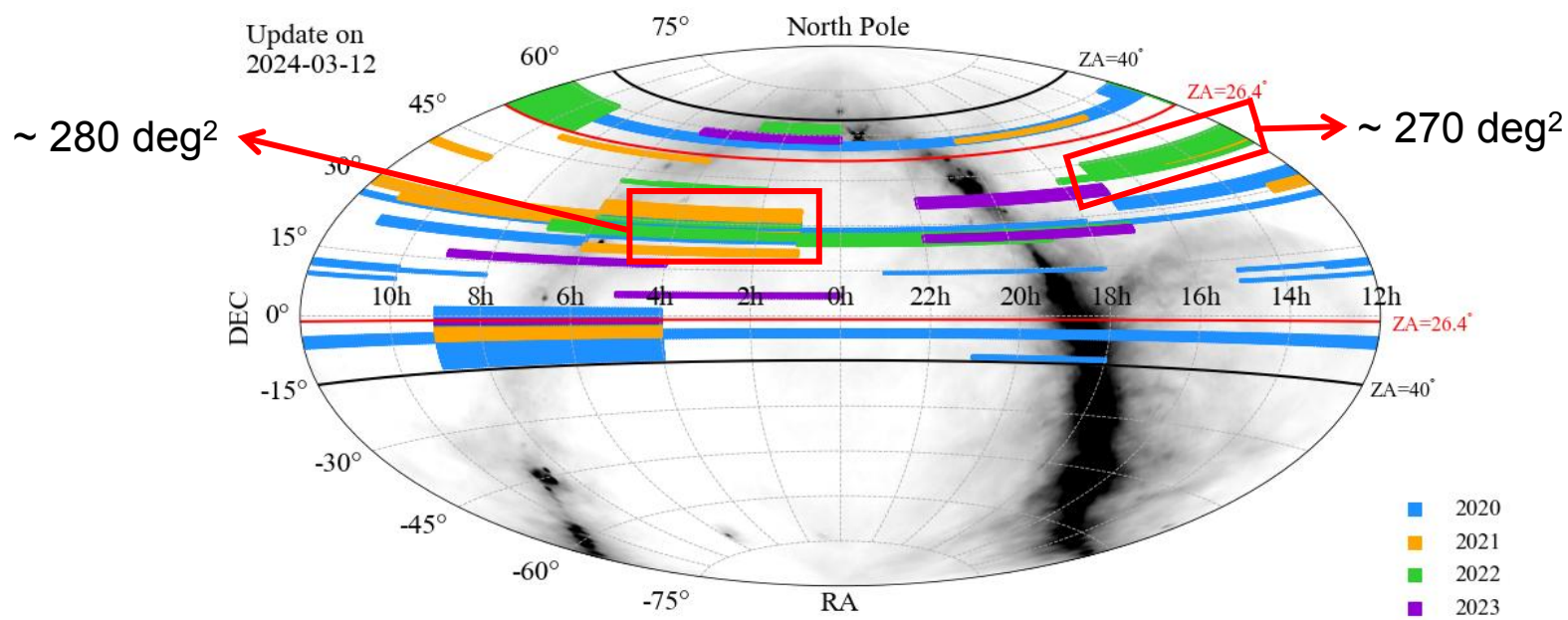


relative error $\sim 6.3\%$

Yichao Li et al. 2023

CRAFTS

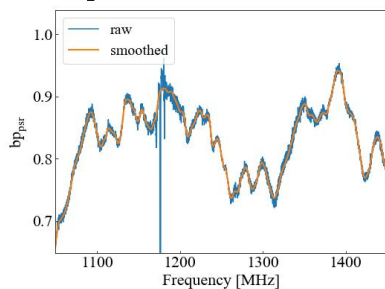
- **CRAFTS** (The **C**ommensal **R**adio **A**stronomy **F**AST **S**urvey)
- pulsar backend + spectrum backend
- calibration mode: **high-cadence noise**(~1K) injection mode: $T_{inj} \sim 196.608\mu s$



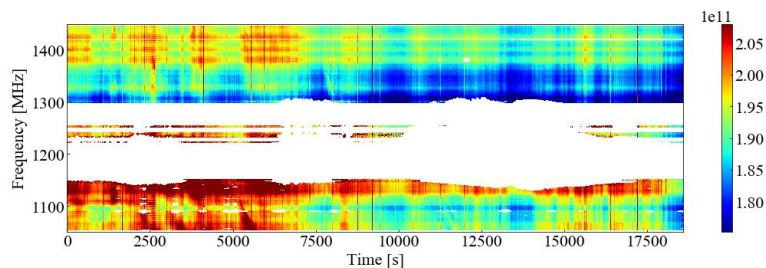
CRAFTS sky coverage ~ 6000deg²

data processing pipeline

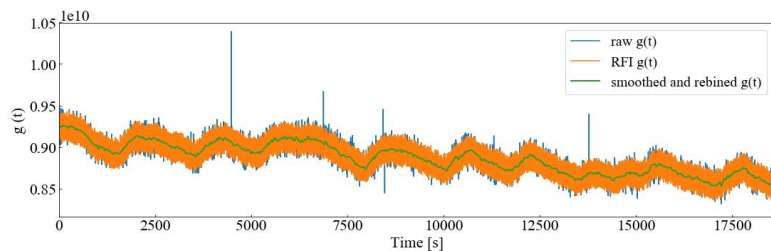
1. bandpass calibration



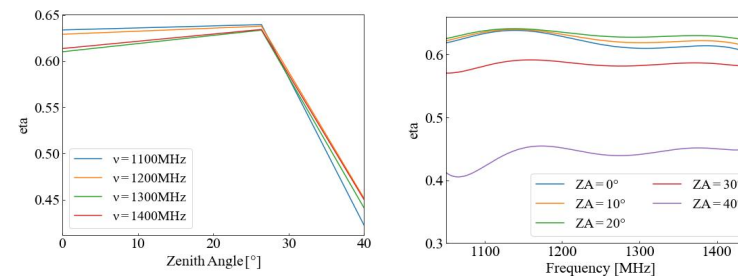
2. RFI flagging



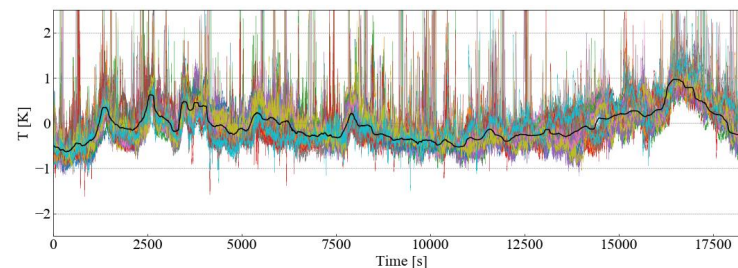
3. temporal drift calibration



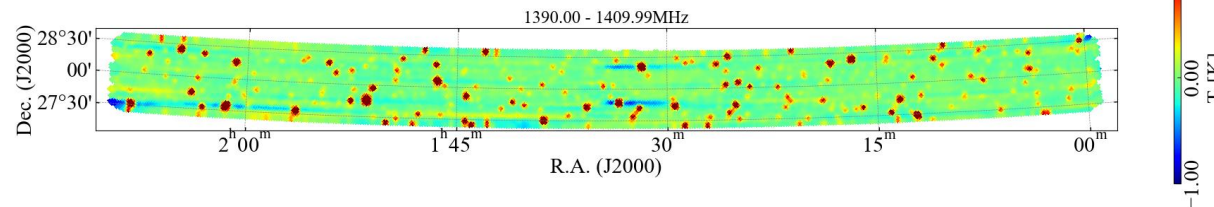
4. absolute flux calibration



5. temporal baseline subtraction



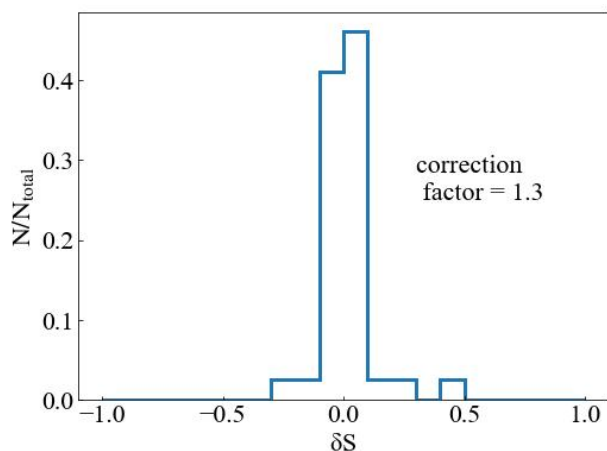
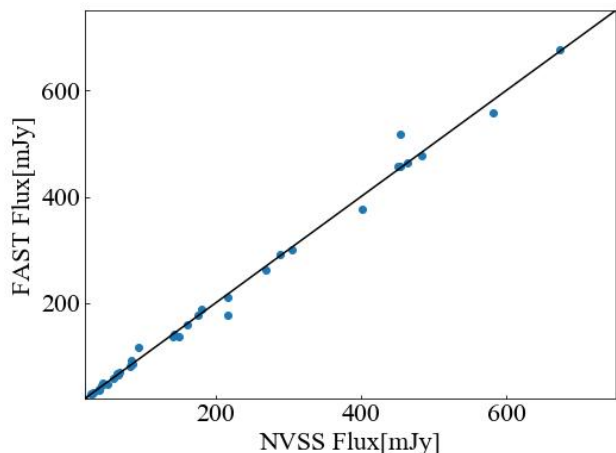
6. map-making



preliminary results - point sources

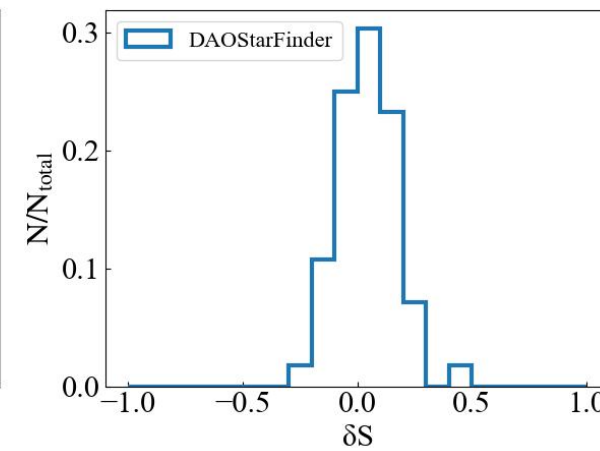
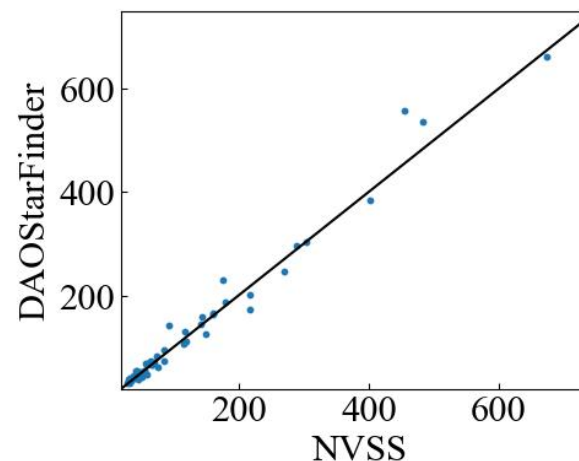
- source selection:
 - no neighbors (flux > 10%) within 9 arcmin;
 - not too faint (flux > 30mJy/beam)
 - well scanned (distance from beam center < 1.5arcmin)

● TOD



● relative error $\sim 10\%$

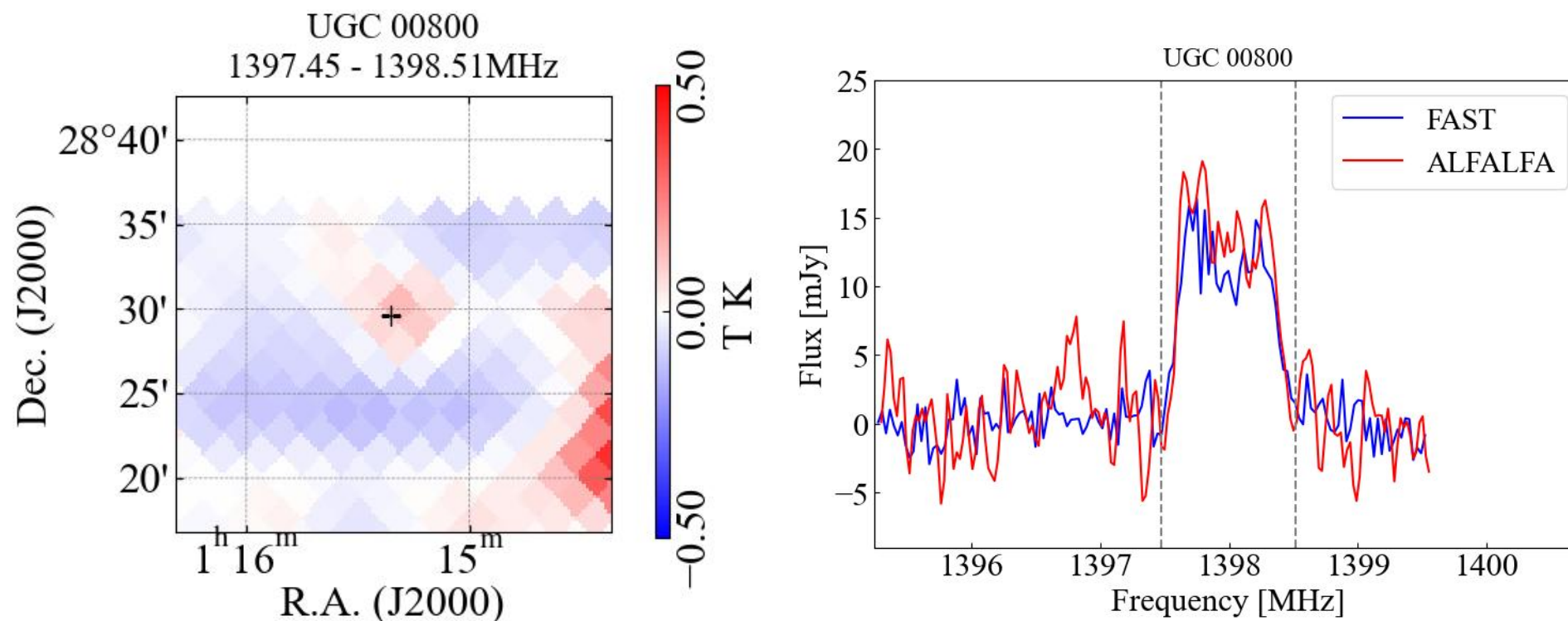
● map (DAOStarFinder)



$\sim 13\%$

preliminary results - HI emission lines

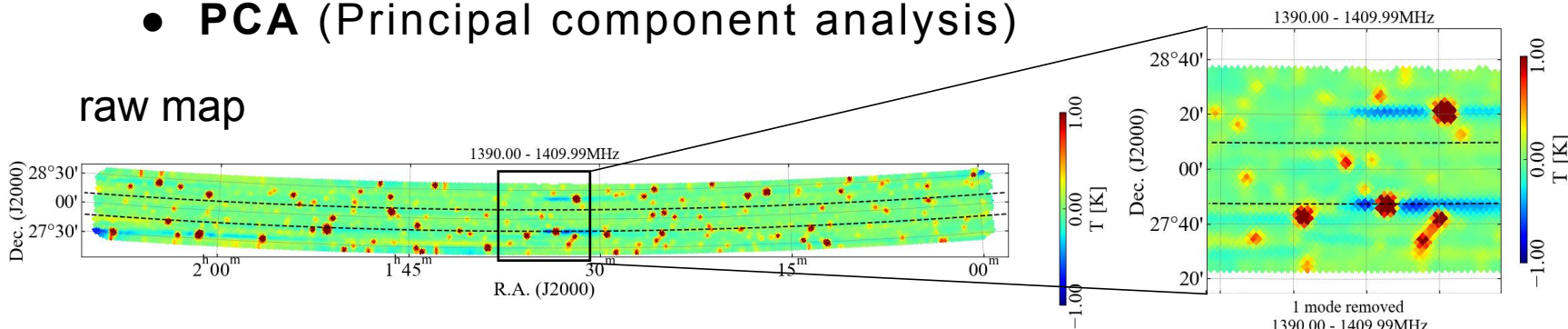
- HI emission line detection (measured on map, compared with ALFALFA)



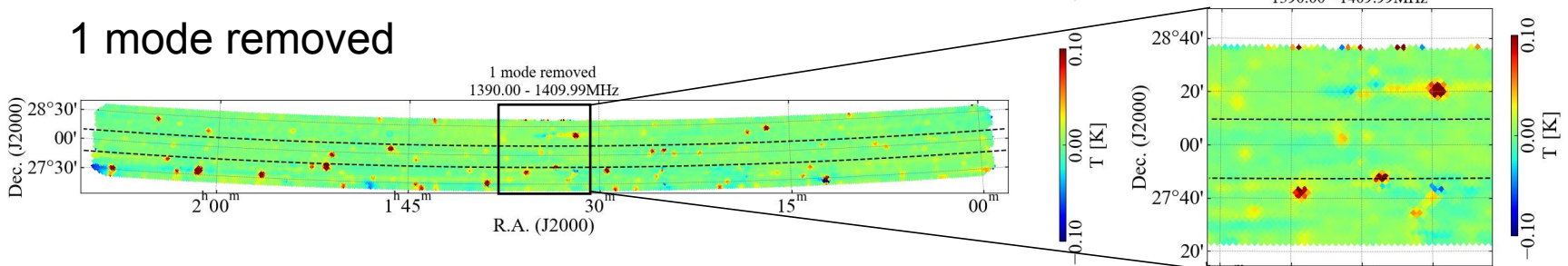
Foreground removal attempts

- **PCA** (Principal component analysis)

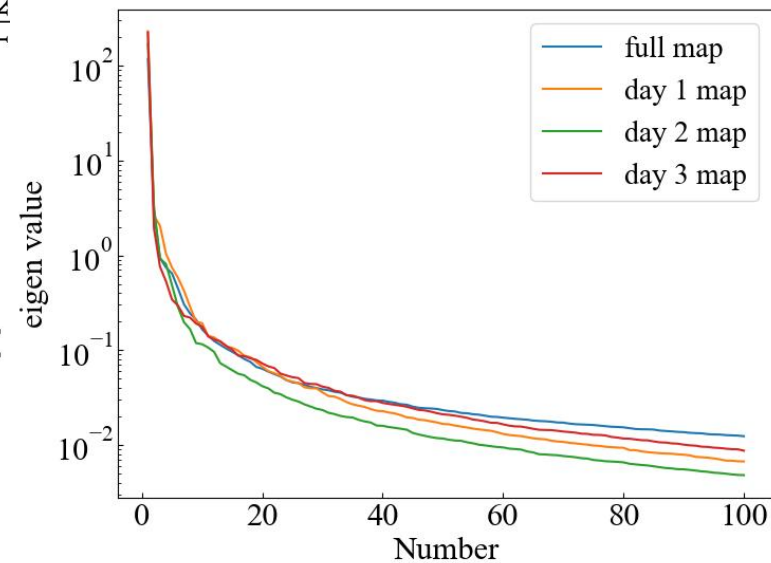
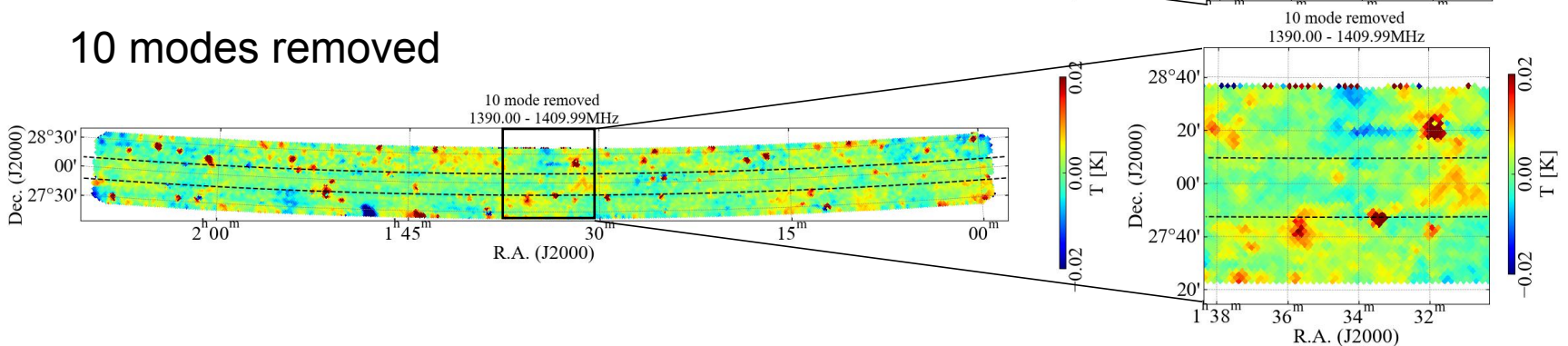
raw map



1 mode removed



10 modes removed



Summary

- FAST, HIIMGS pilot survey & CRAFTS
- preliminary results, e.g. good detection of continuum sources & HI emission
- foreground removal tests with PCA
- current challenges: standing waves, artifacts on map, RFIs...

Thanks!

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