The drift scan survey with MWA

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Murchison Widefield Array

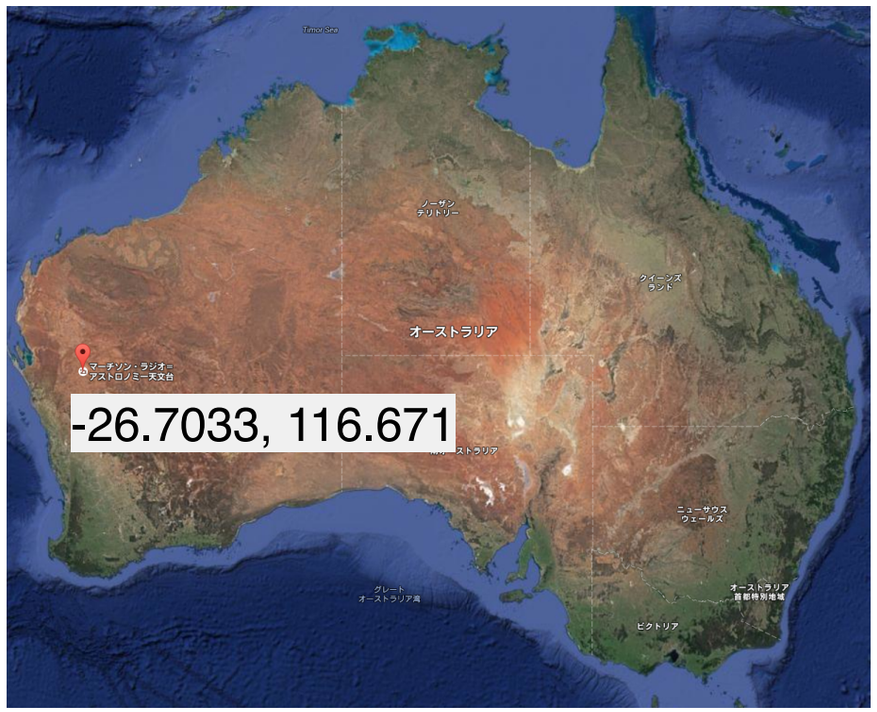
Credit : Natasha Hurley-Walker

Precursor of SKA

Main science : detecting 21cm line at EoR

MWA dipole antenna

1 tile has 4×4=16 dipoles

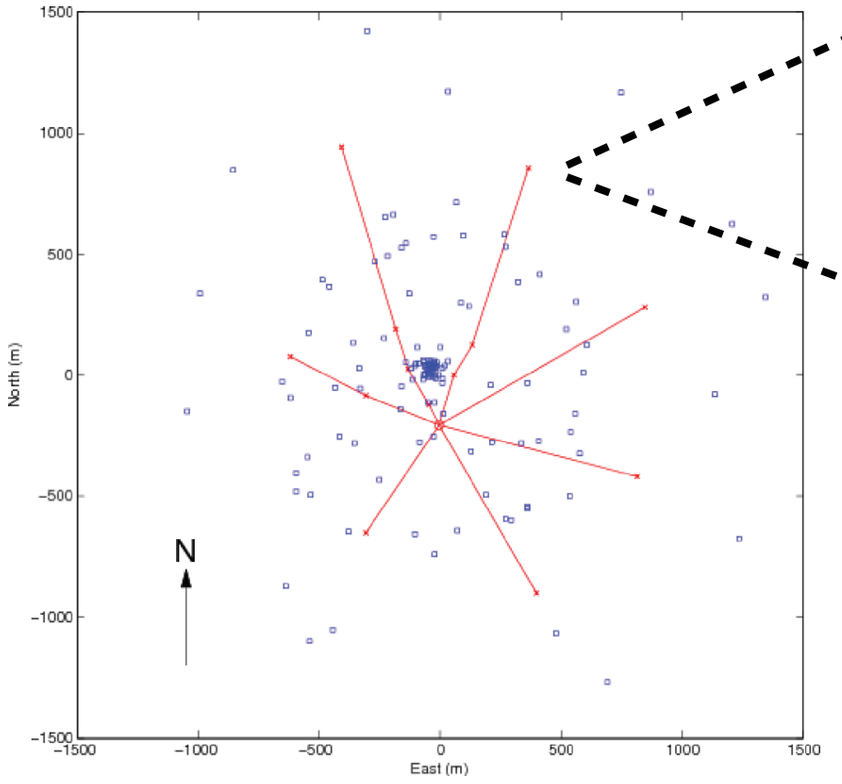


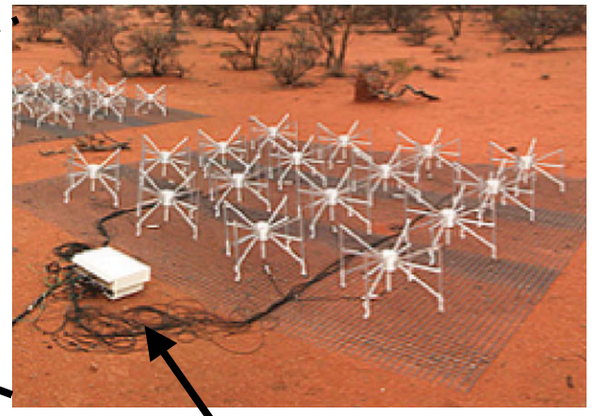
Summary of MWA properties

Frequency range	80 - 300 MHz
Number of receptors	2048 dual polarization dipoles
Number of antenna tiles	128
Number of baselines	8128
Collecting area	Approx. 2000 sq. meters
Field of view	Approx. 15 - 50 deg. (200 - 2500 sq. deg.)
Instantaneous bandwidth	30.72 MHz
Spectral resolution	40 kHz
Temporal resolution	0.5 seconds
Polarization	Full Stokes (I, Q, U, V)
Array configuration	50 antenna tiles within 100 meters 62 antenna tiles between 100 and 750 meters 16 antenna tiles at 1500 meters

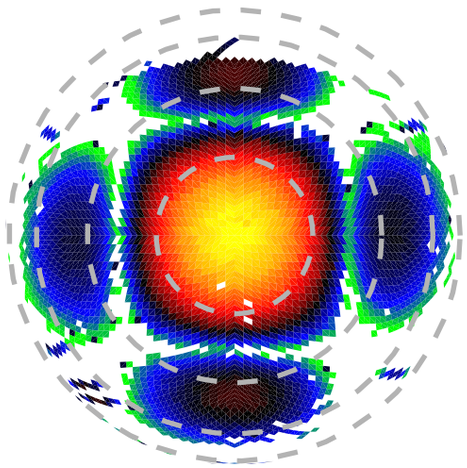
Murchison Widefield Array

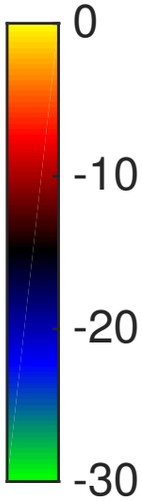
Tile configuration





Beam former





Beam shape

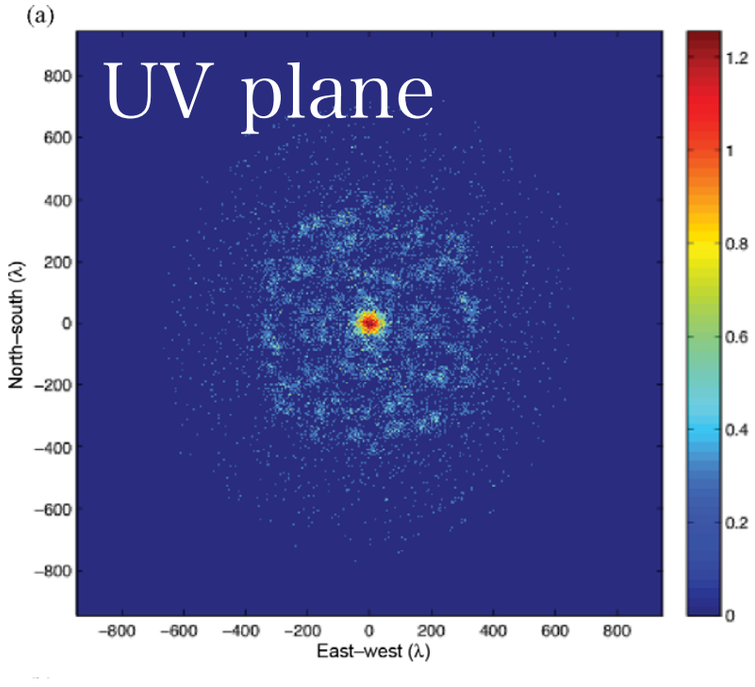
2480 dipole

128 tile

8128 baseline

Collecting area 2000m^2

Maximum baseline 2864m



Images : Tingay et al 2012

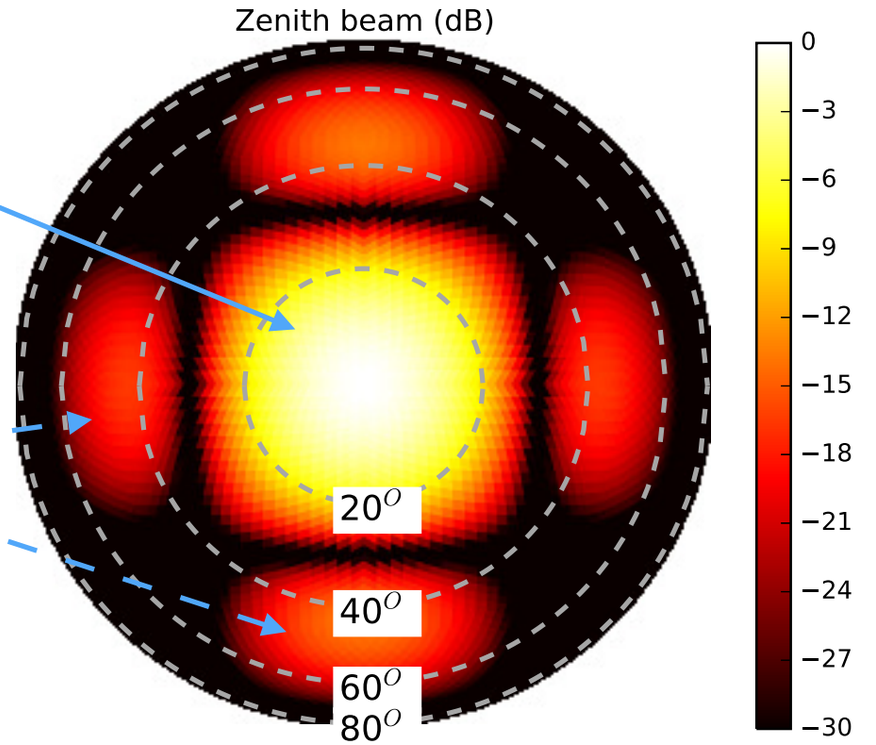
Murchison Widefield Array

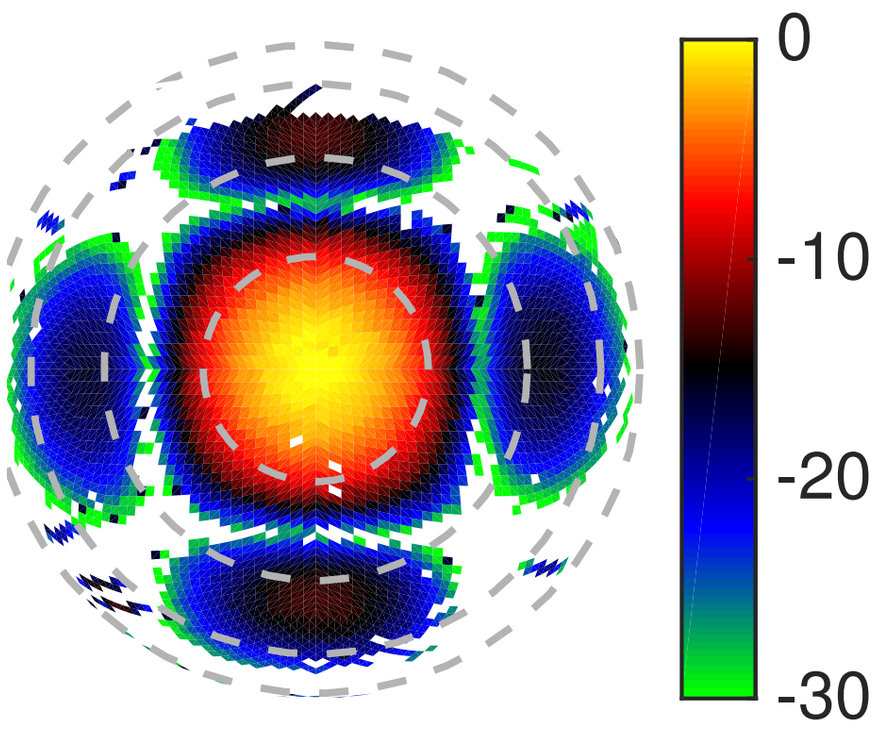
Ideal model (zenith)

Observed beam (zenith)

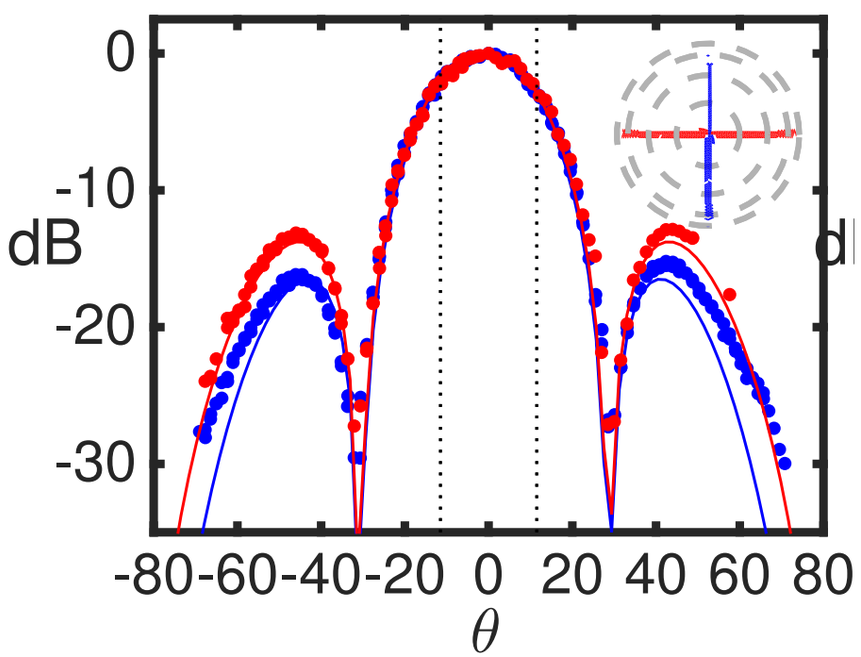
Primary beam
~20°

Side lobes





Neben et al 2015 & 2016



Difference between
model (line) and observation (points)

Murchison Widefield Array

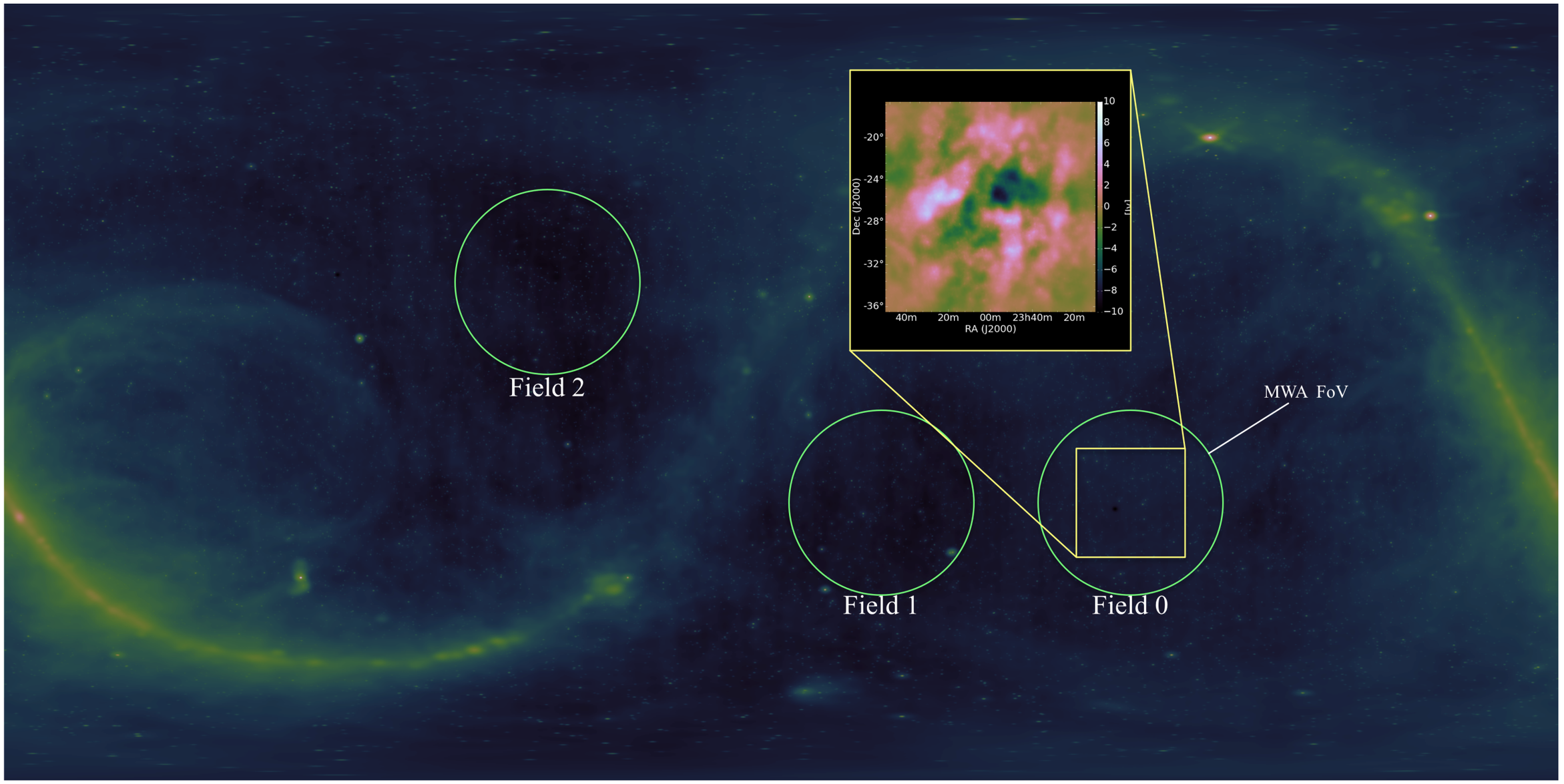


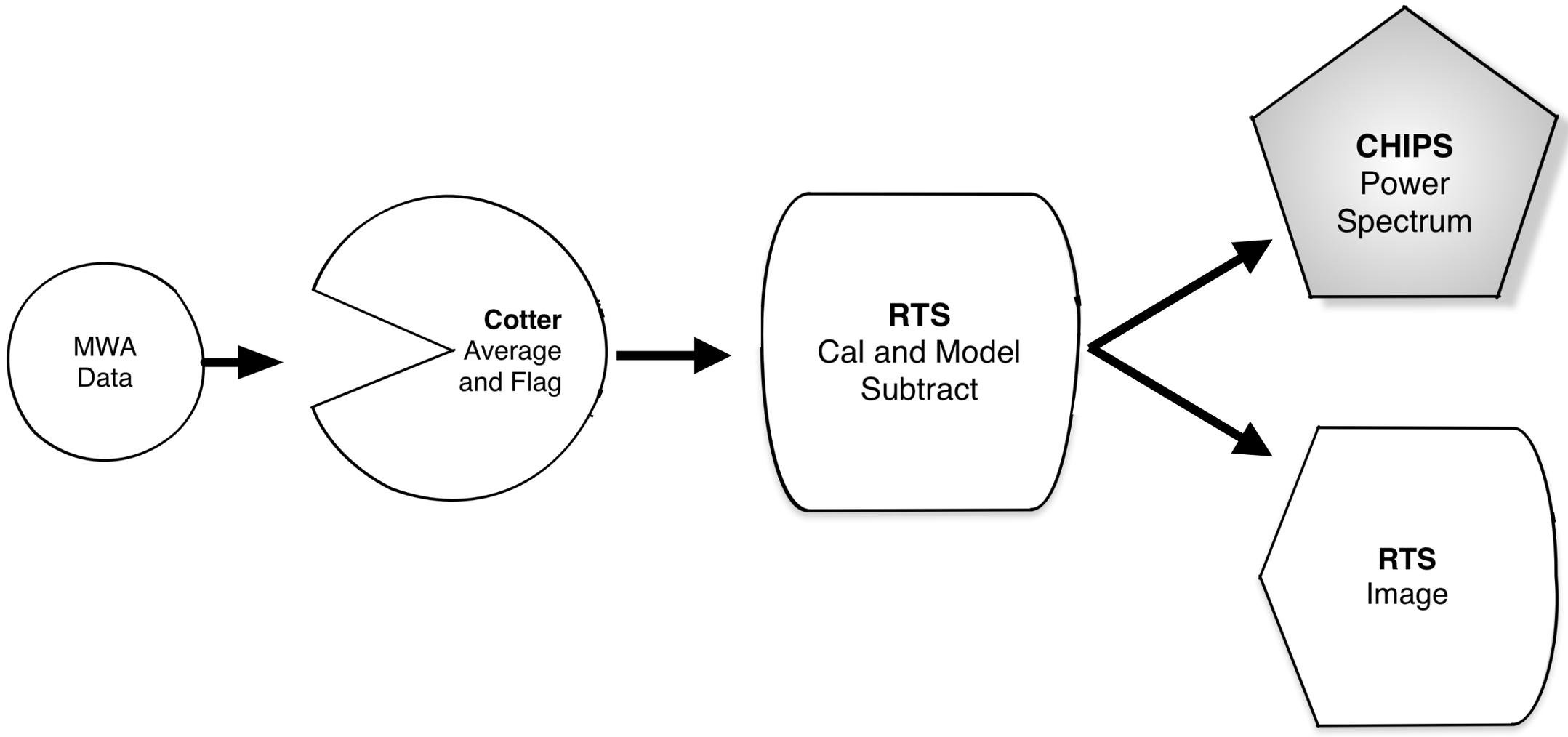
Image : Jacobs et al 2016

Three fields for EoR

Field 0 : centered on Dec -27° , RA 0h

Calibration

Calibration process



Jacobs et al 2016

Drift scan dataを使ったデモンストレーションを行う。

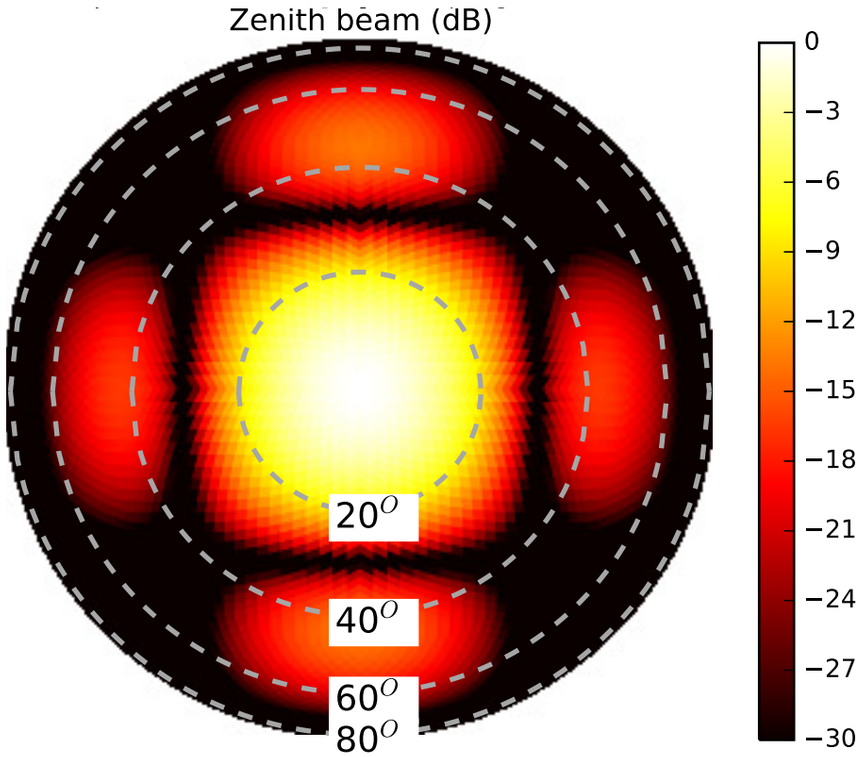
Drift scan survey with MWA

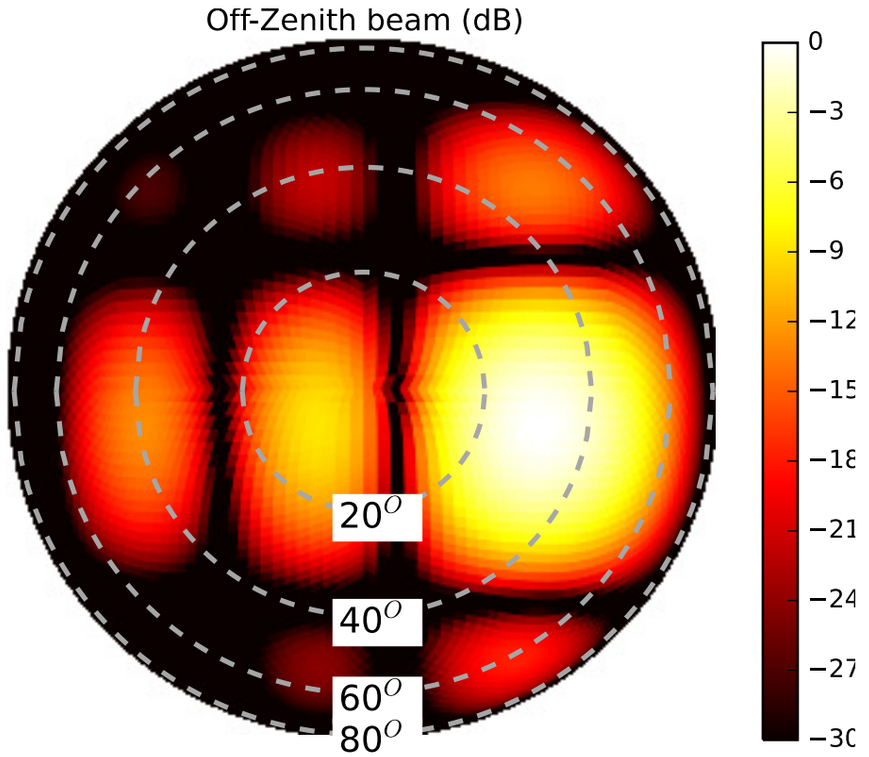
Drift scan

アンテナのビームの向きをzenithに固定し、空を掃くように観測

メリット

・ビームの形が安定しているので、キャリブレーションがしやすい





Neben et al 2016

Drift scan data

Data property

Pointing Center RA,Dec = 0.0, -26.70

Imaging Center
from RA,Dec = 23.7, -26.70 to RA,Dec = 1.25, -26.70

Center frequency = 182.415 MHz

Bandwidth = 30.72 MHz

Snapshot :112s

Total : 1.5 hour

Calibration : flagging

Flagging & Average

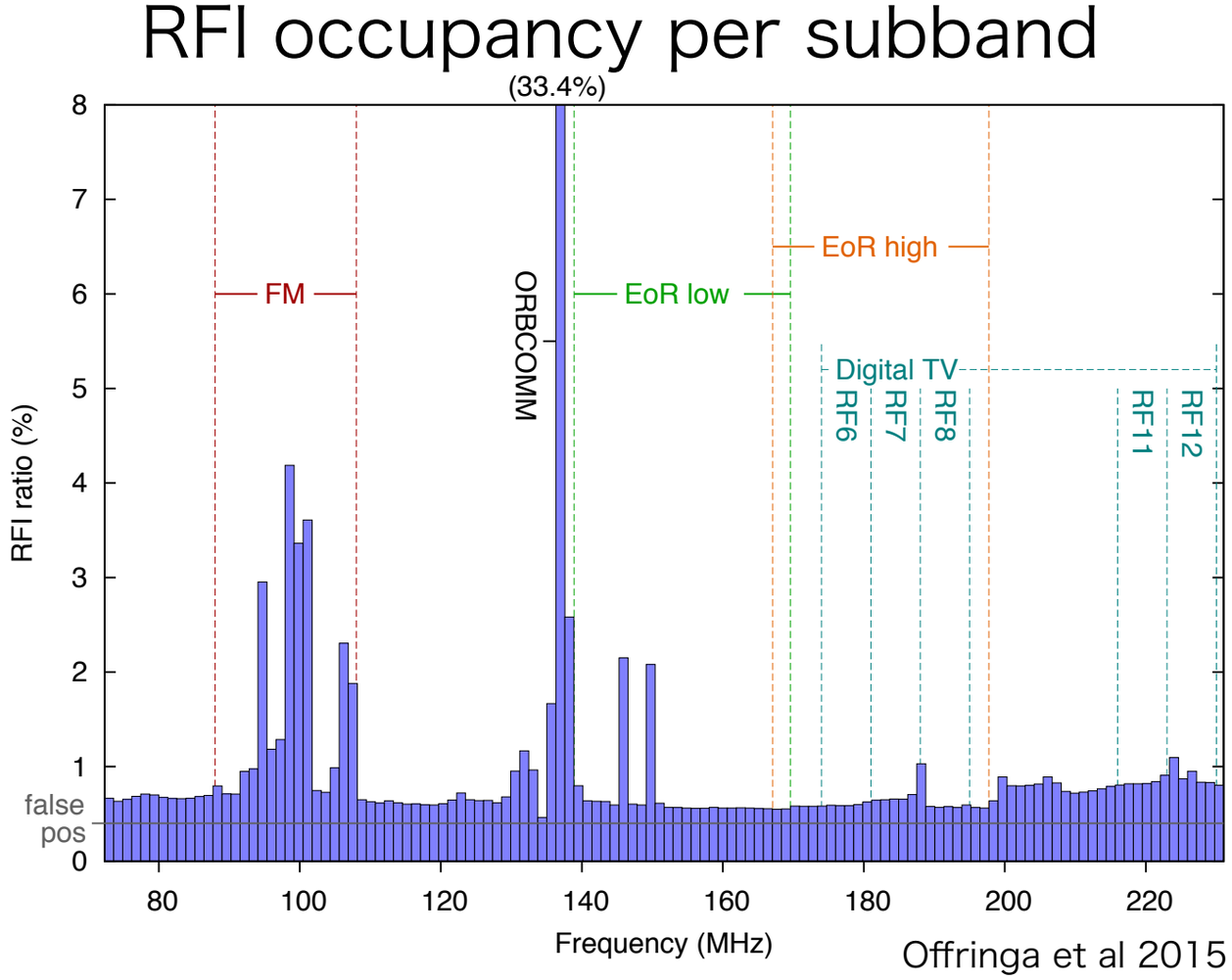
AOFLAGGER : Automatic flag coarse band and RFI.

flagging of about 1% of the data

Data averaging

2~4s and 40~80kHz

to reduce data volume



Offringa et al 2015

RTS Real Time System

Data processes each 112s snapshots & 40kHz channels

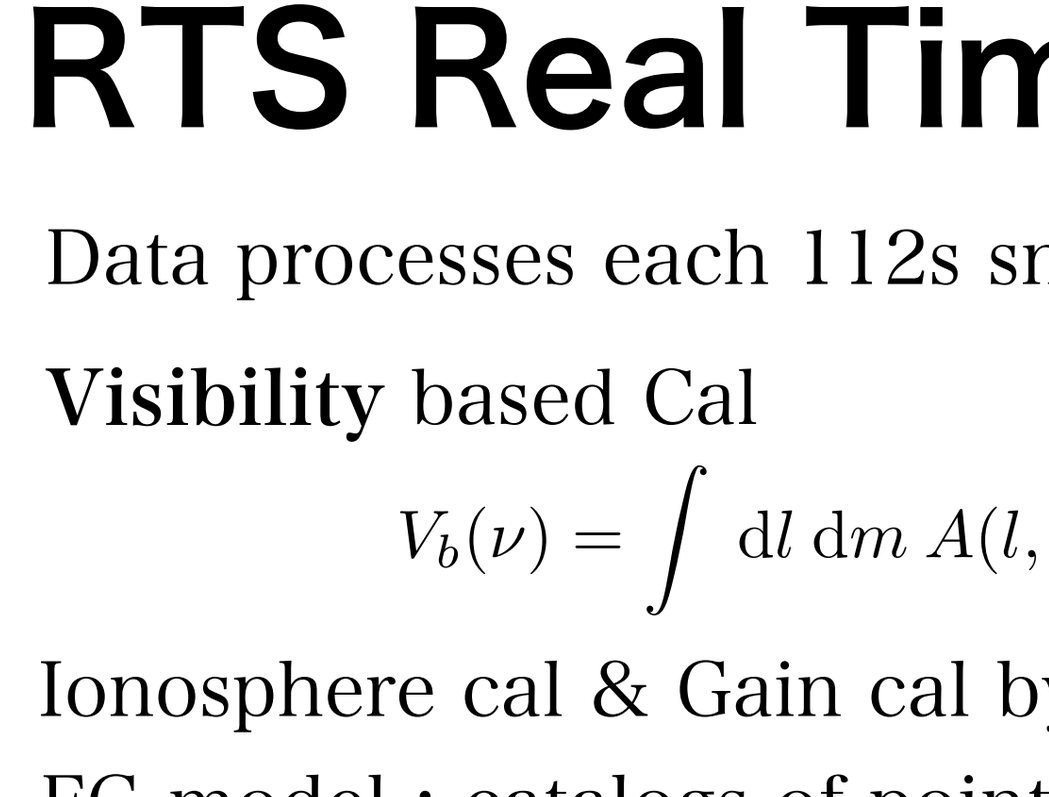
Visibility based Cal

$$V_b(\nu) = \int \mathrm{d}l\, \mathrm{d}m\, A(l,m,\nu)\, I(l,m,\nu)\, e^{-2\pi i(ul+vm)}$$

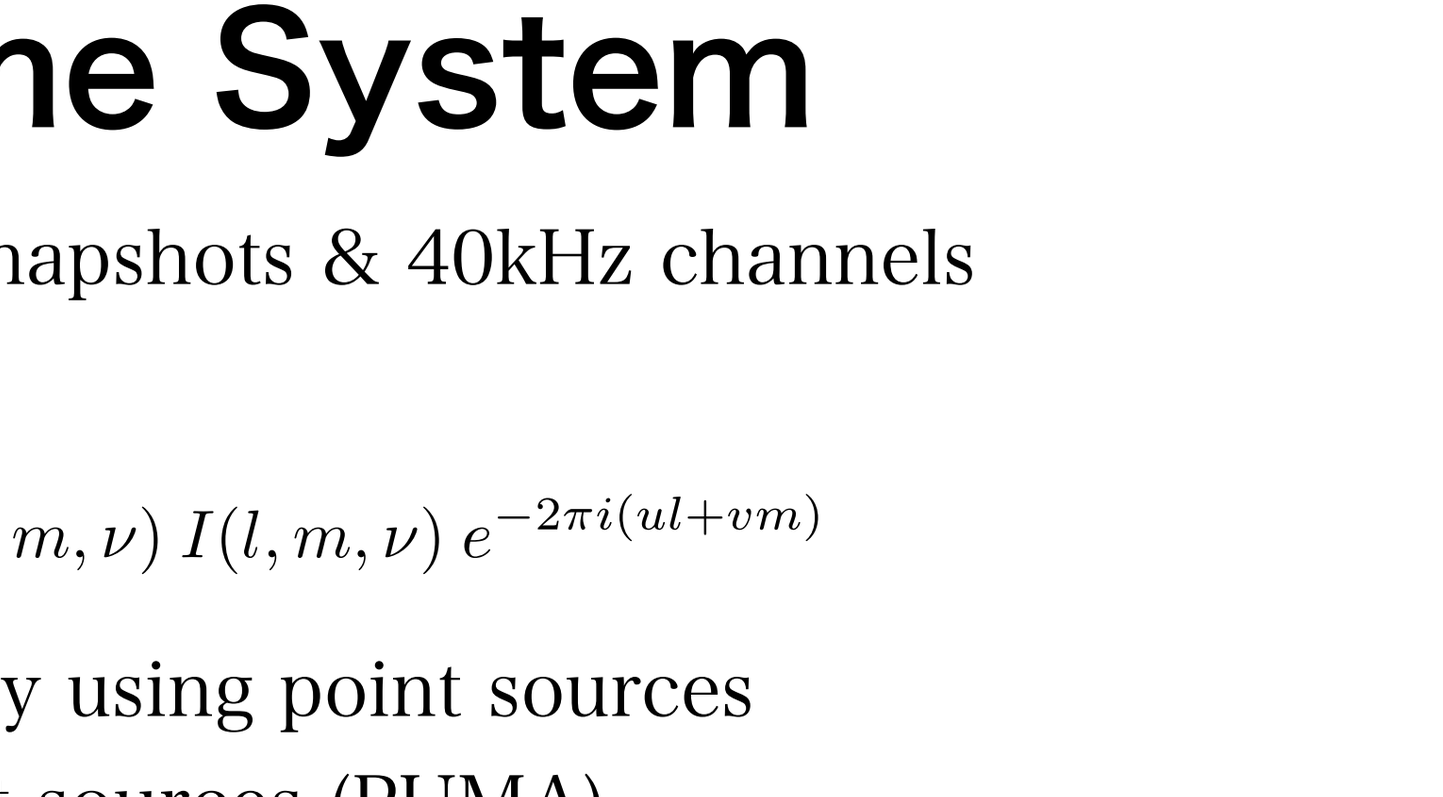
Ionosphere cal & Gain cal by using point sources

FG model : catalogs of point sources (PUMA)

after calibration, model is subtracted from data



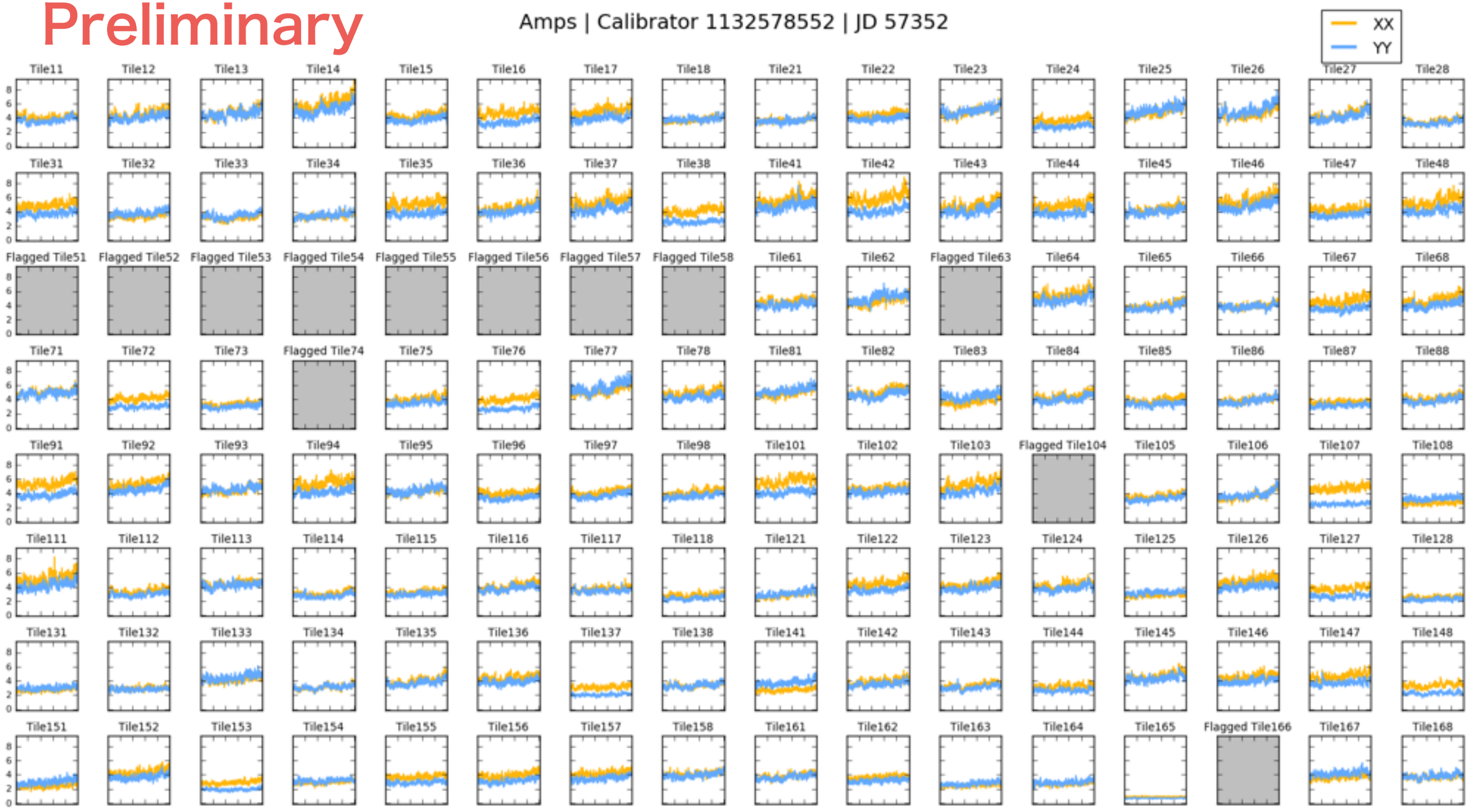
Jelic et al 2008



Mitchell et al 2008

Drift scan data : calibration result

Preliminary



Gray panels show flagged tiles.

x axis : frequency

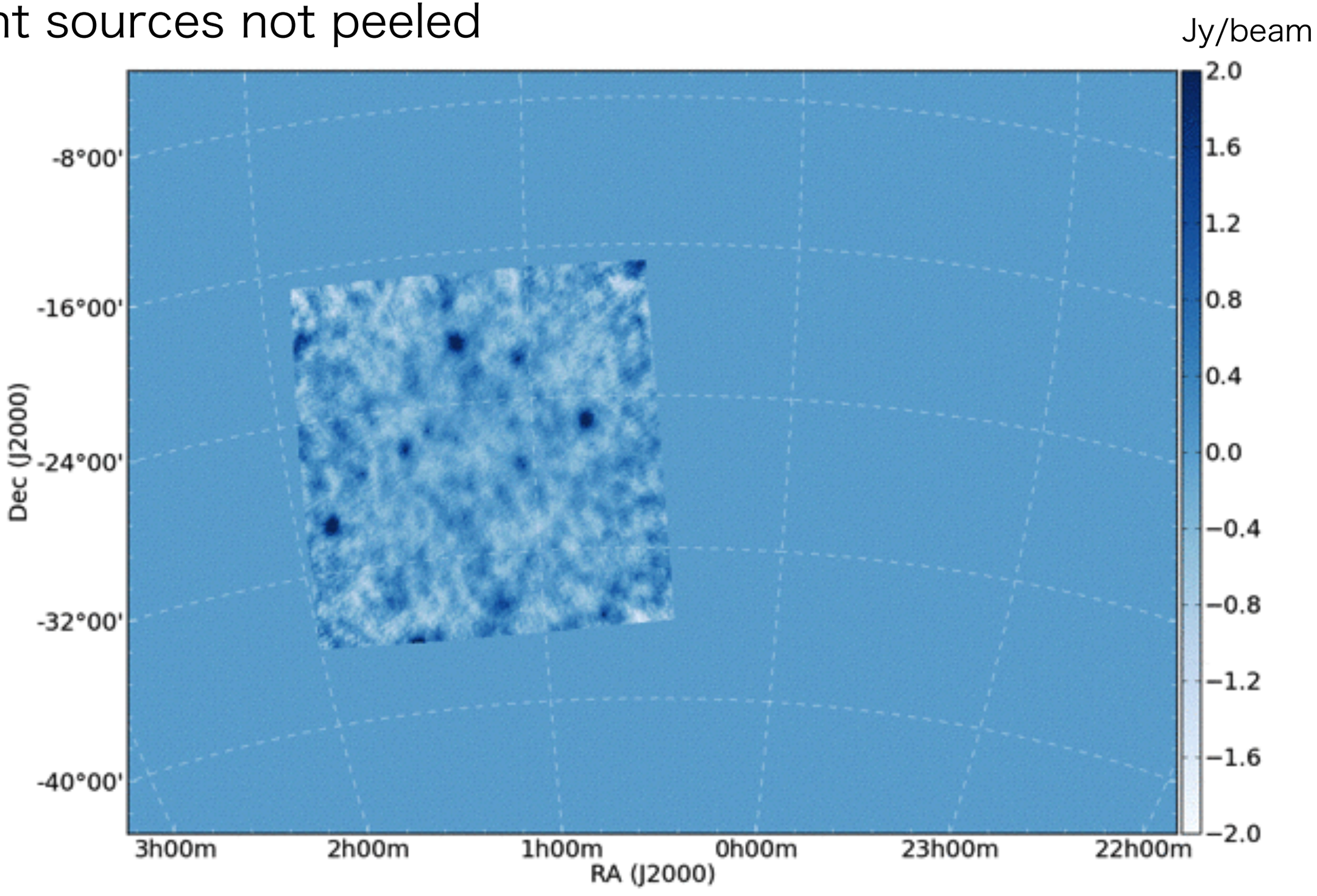
y axis : amplitude

Drift scan data : image not peeled

Preliminary

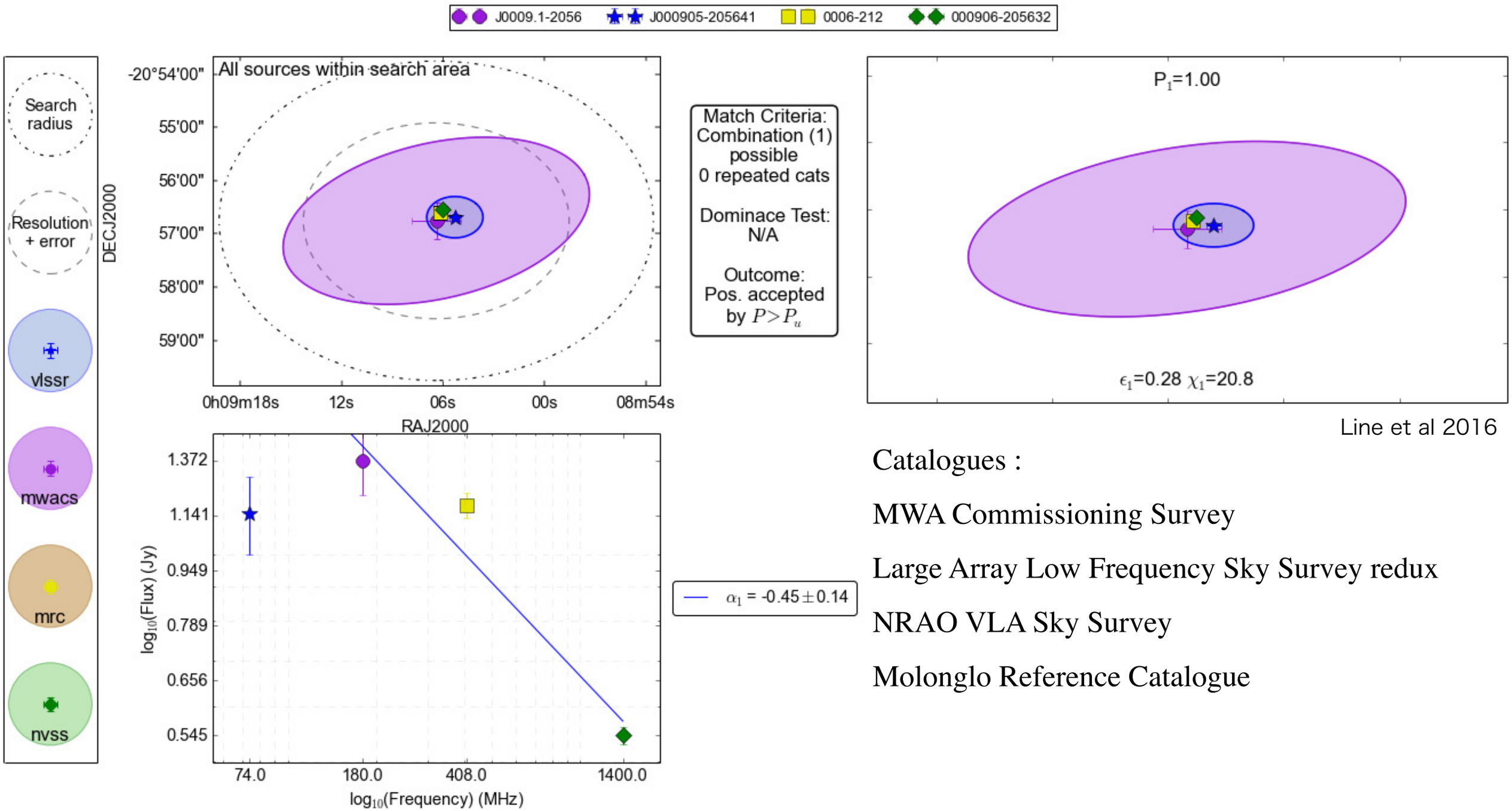
Imaged by RTS

Point sources not peeled



Calibration : point source

Point source catalogues : PUMA (Line et al 2016)



Line et al 2016

Catalogues :

MWA Commissioning Survey

Large Array Low Frequency Sky Survey redux

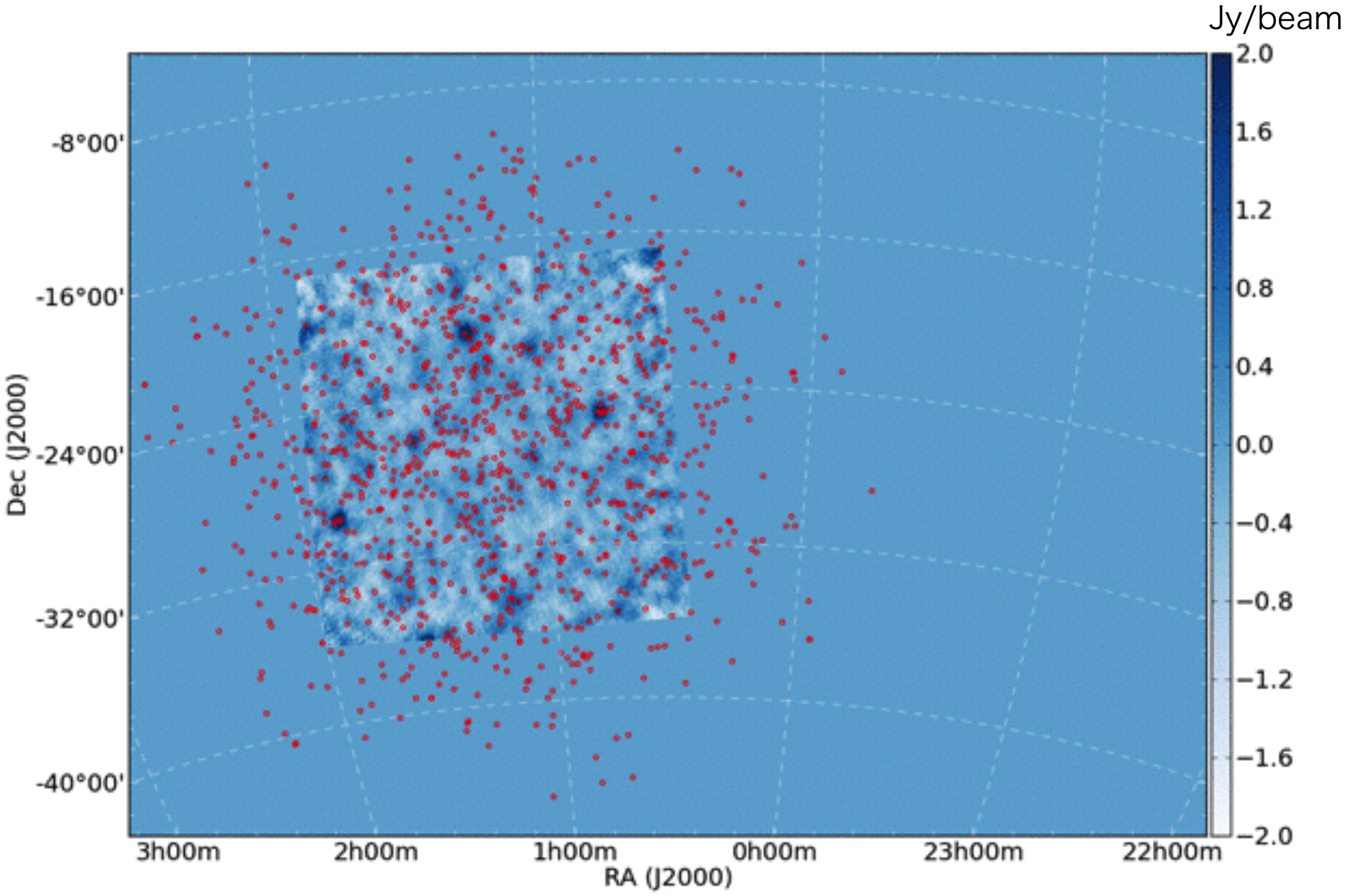
NRAO VLA Sky Survey

Molonglo Reference Catalogue

Drift scan data : image with sources

Preliminary

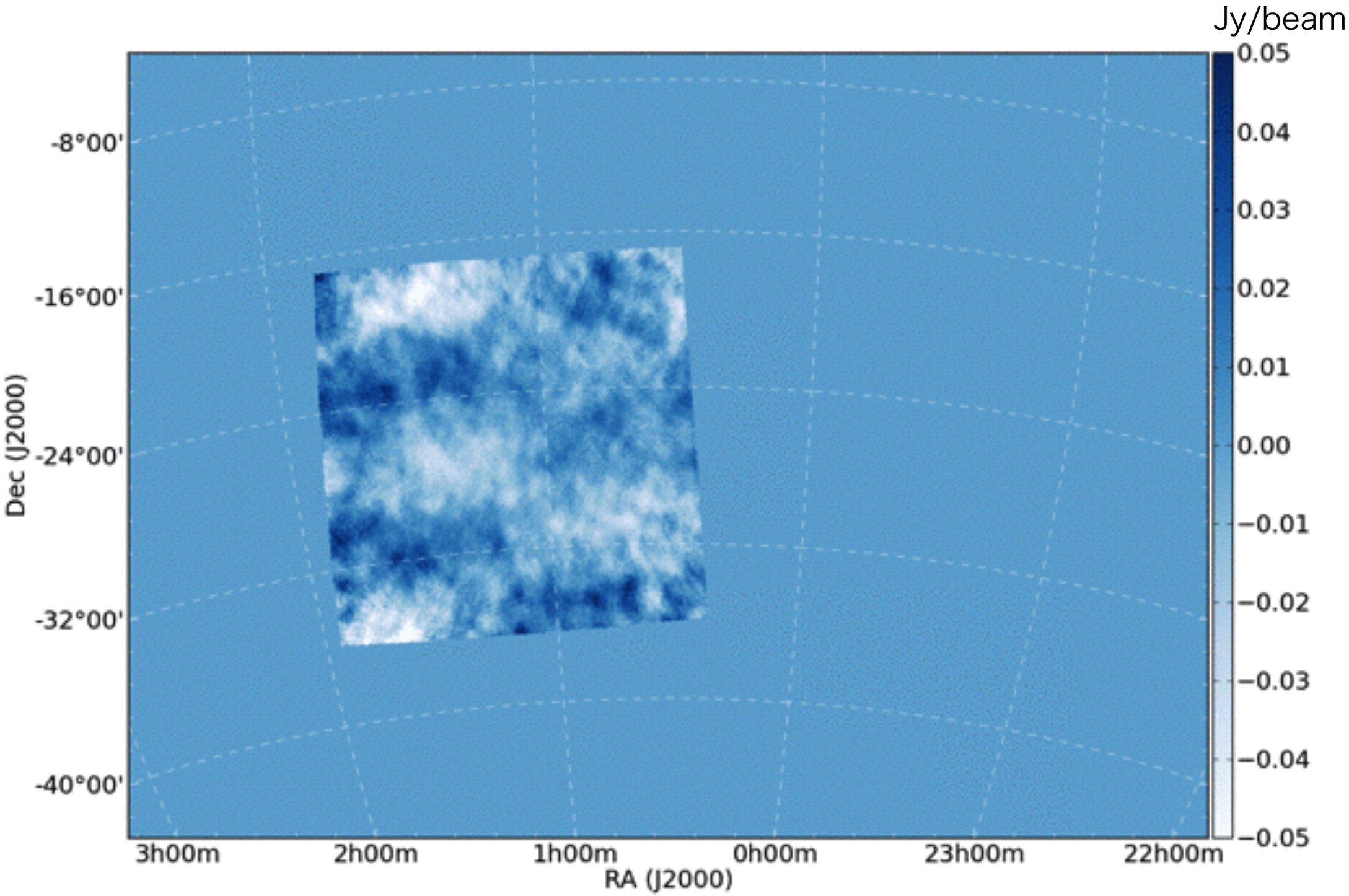
Point sources listed by PUMA



Drift scan data : peeled image

Peeling 1000 point sources

Preliminary



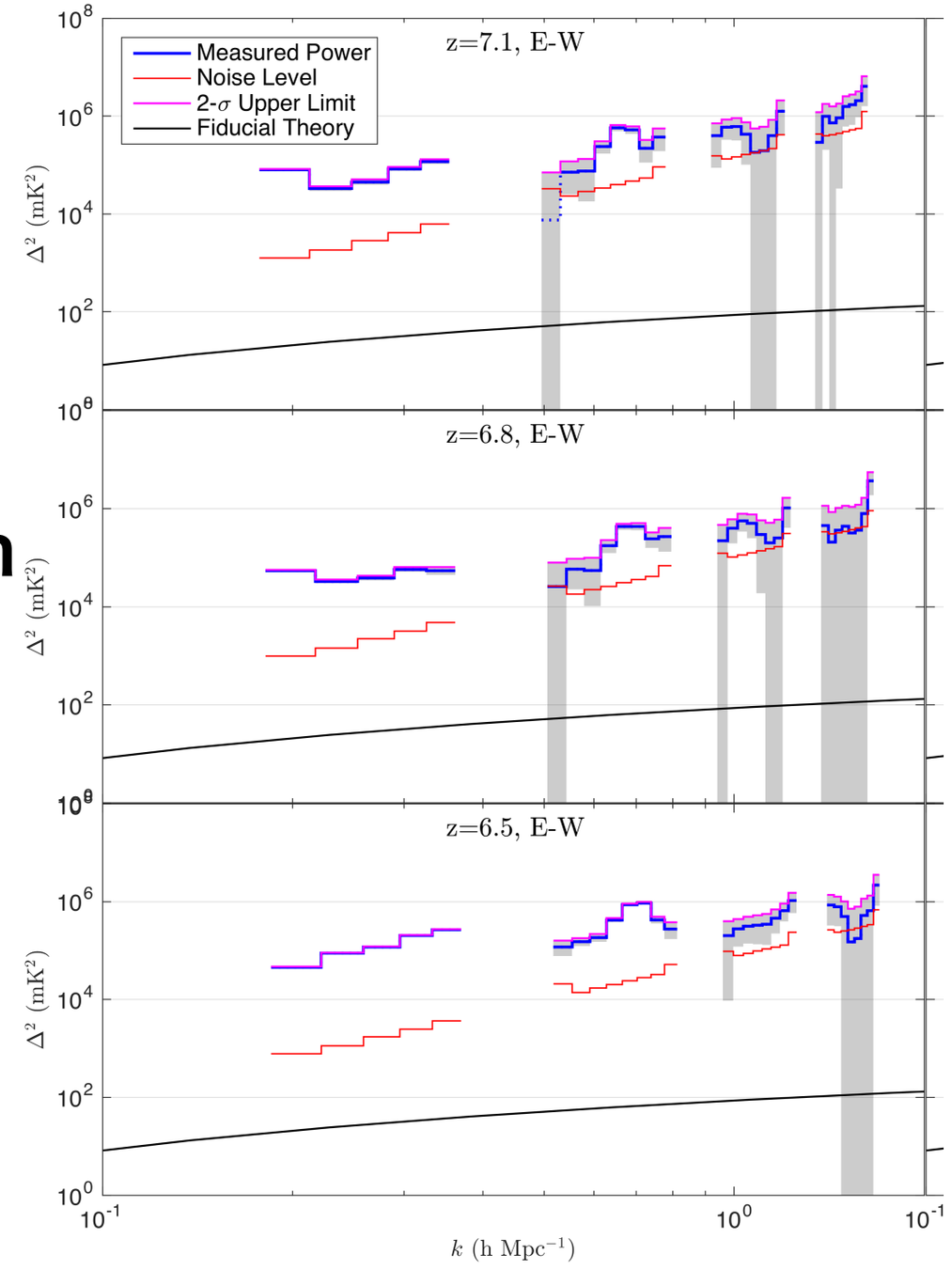
Drift scan data : future work

Power spectrum

DRIPS will be developed

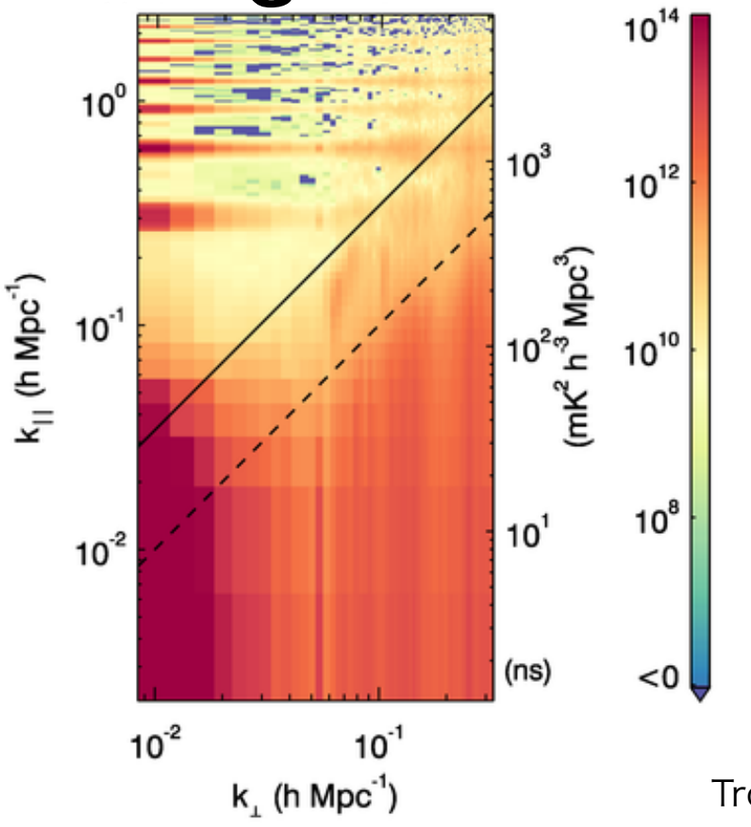
2D power spectrum estimator

based on CHIPS (Trott et al 2016)



Beardley et al 2016

Compare with pointing observation



Trott et al 2016

2D power spectrum

Summary

MWAの観測データを使ったキャリブレーション

- Drift scan data
- RTS (Mitchel et al 2008)
- PUMA (Line et al 2016)

今後のMWA-jpの具体的な活動として、

Drift scan survey data を使ったデータ解析

- ・Estimate 2D power spectrum
- ・Compare with pointing observation

Cross correlation with LAE (Kubota+)

Cross correlation with CMB (SY+)