

Faraday Tomography with LOFAR

Cameron Van Eck, Marijke Haverkorn
Radboud University, Nijmegen



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Background: IC342 as seen by LOFAR (Stokes I)

Faraday Tomography with LOFAR

- Faraday tomography
- First results: the IC342 field

Faraday rotation

- Faraday rotation causes polarization to **rotate**, with a wavelength dependence:

$$\Delta\psi = \lambda^2 \left(0.81 \int_0^d n_e \vec{B} \cdot d\vec{l} \right) = \lambda^2 \phi$$

- **Multiple** polarized sources at different distances rotate at **different rates**, and superimpose, producing non-linear behaviour.

Faraday rotation

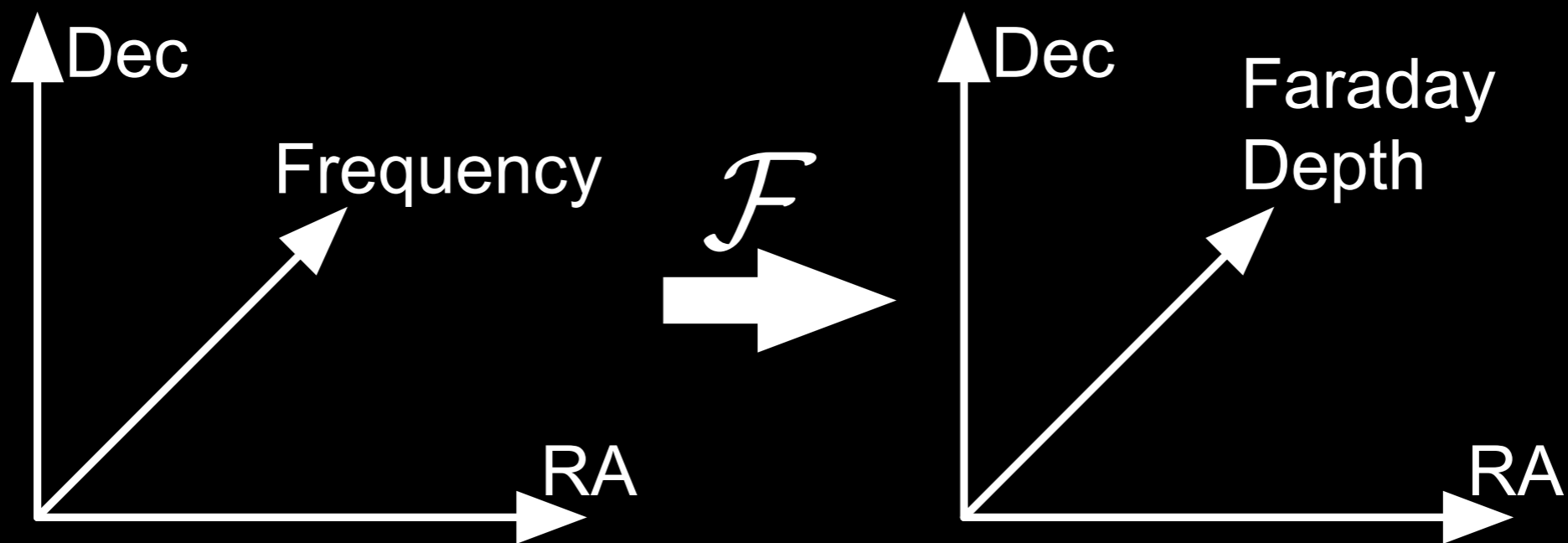
- Rotation is periodic, amenable to **Fourier** transform analysis:

$$P(\lambda^2) \xrightarrow{\mathcal{F}} P(\phi)$$

- Different polarized sources show up at different **Faraday depths**, can be identified and characterized.

Faraday Tomography

- Broad-band radio polarization cubes can be transformed into **Faraday depth cubes**:

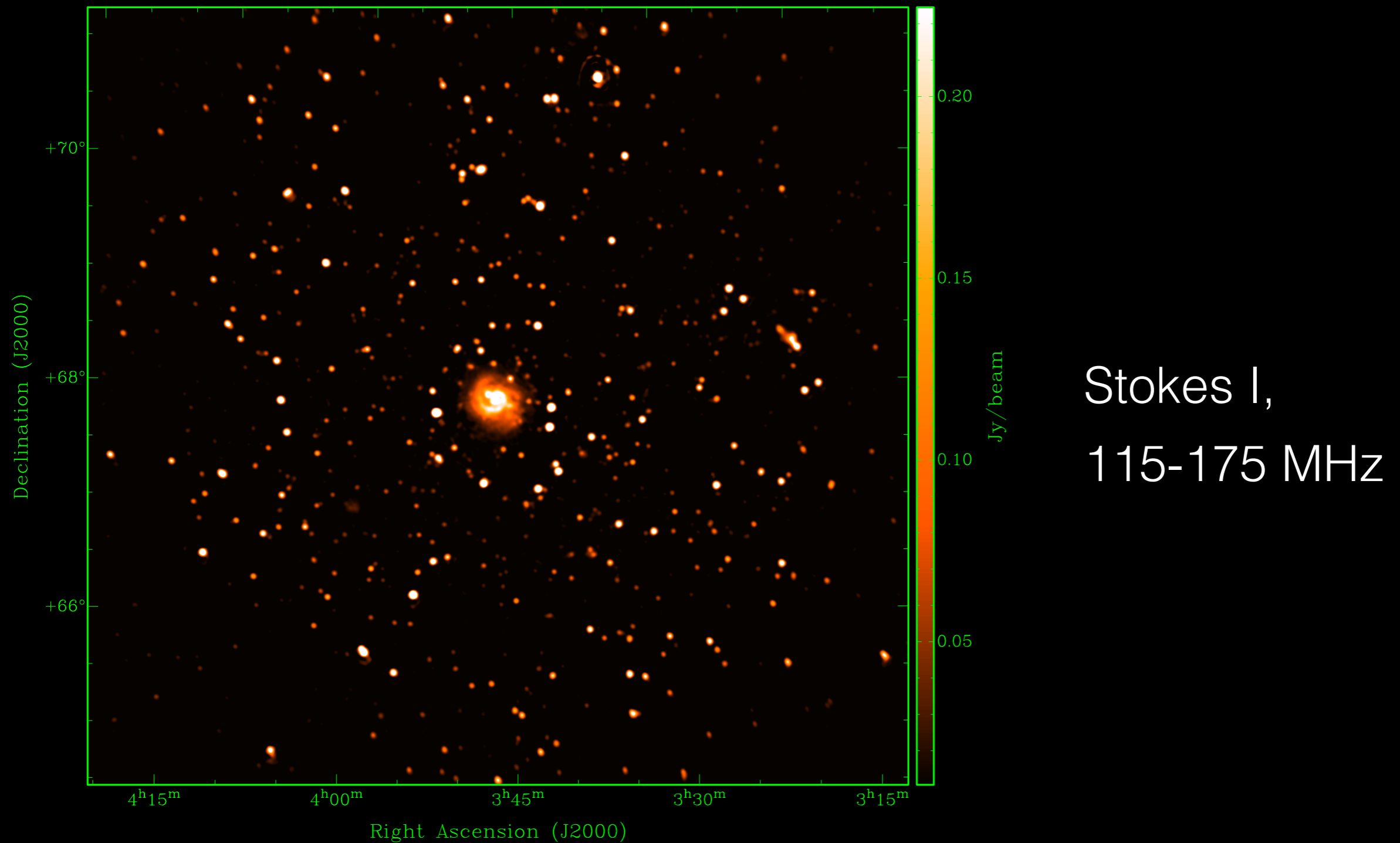


- Weak polarized emission at all frequencies is concentrated into only a few frames in the Faraday cube.

Faraday Tomography

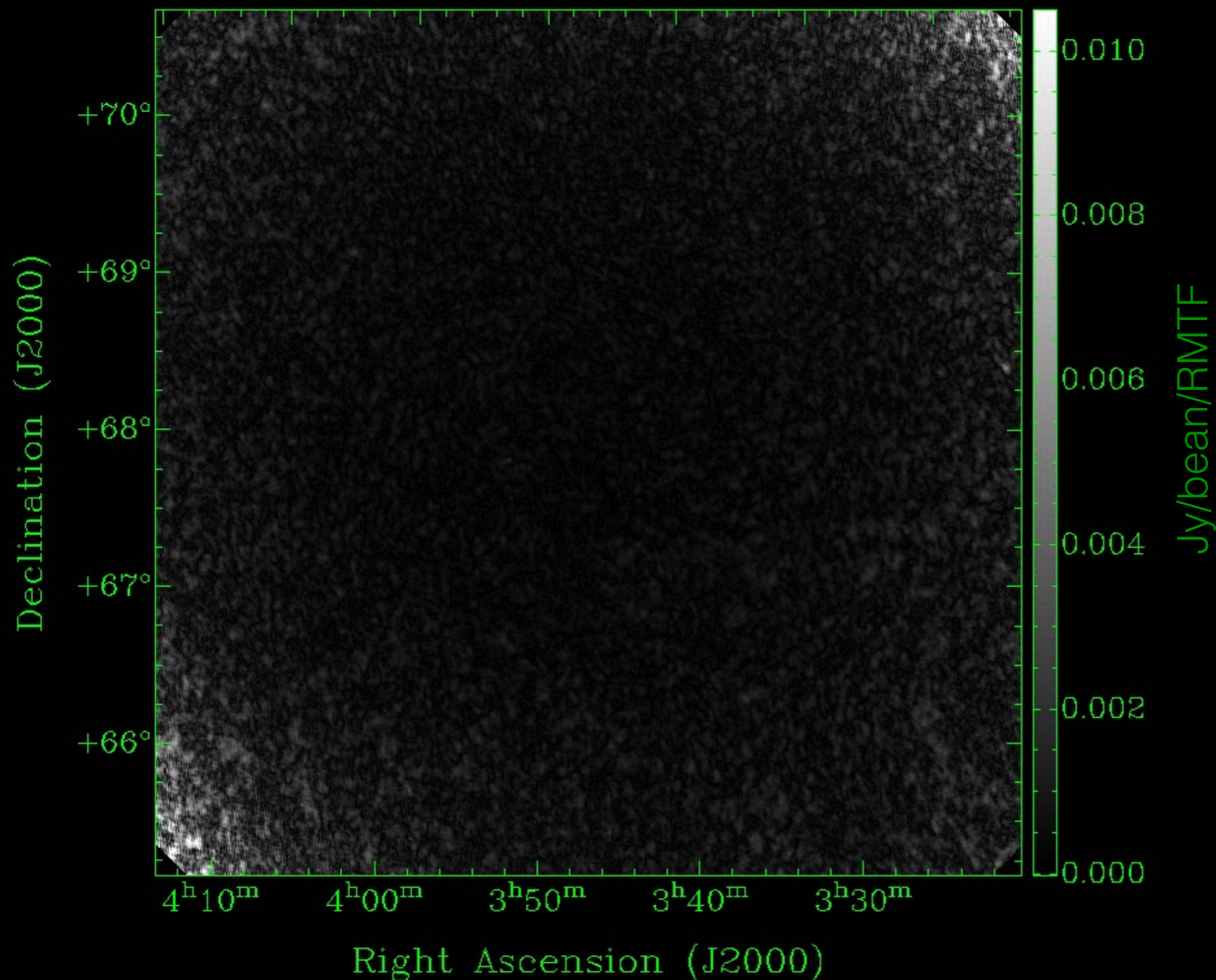
- Resolution in Faraday depth space depends on the **wavelength coverage**: broader coverage gives better resolution.
- LOFAR has **extremely good** Faraday depth resolution, around 1 rad/m^2 , due to its large fractional bandwidth and long wavelengths.

IC342 field



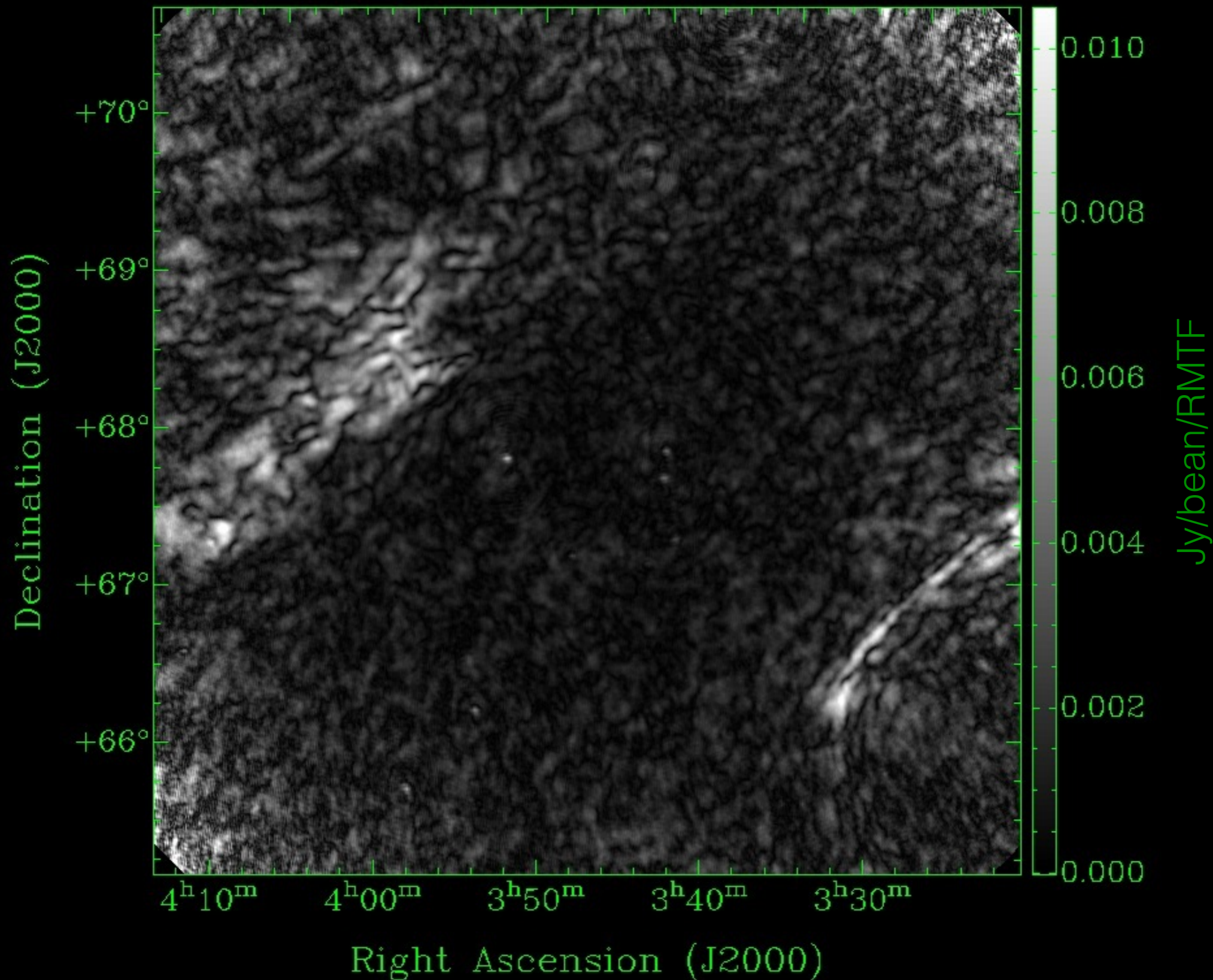
IC342 field: Faraday tomography

Phi: $-1.000000e+01$

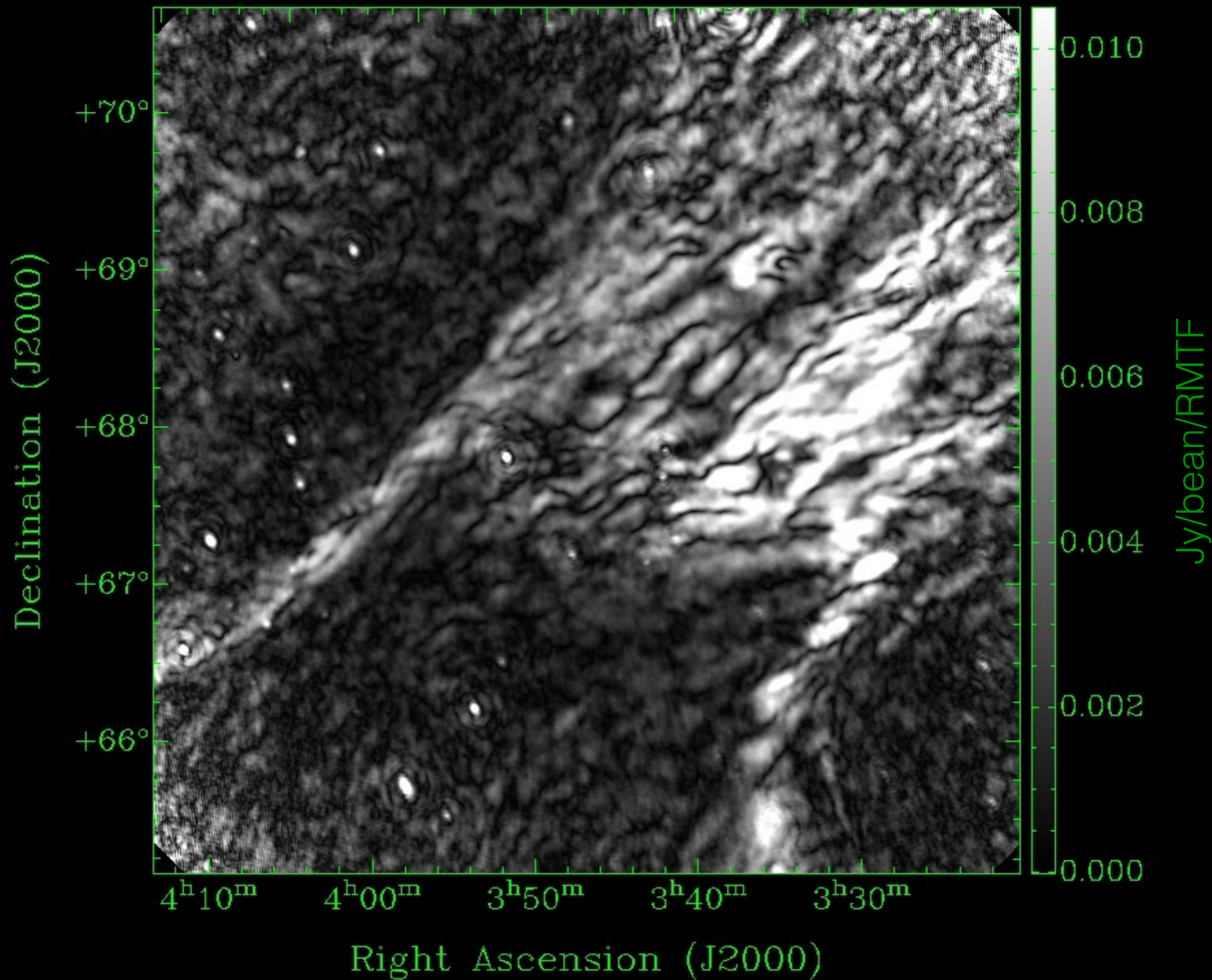


- Noise level:
0.1 mJy/beam/
RMTF
(~ 0.25 K)
- Angular Resolution:
2.4'
- Faraday depth
resolution:
1 rad/m²
- Field of view:
5°x5°

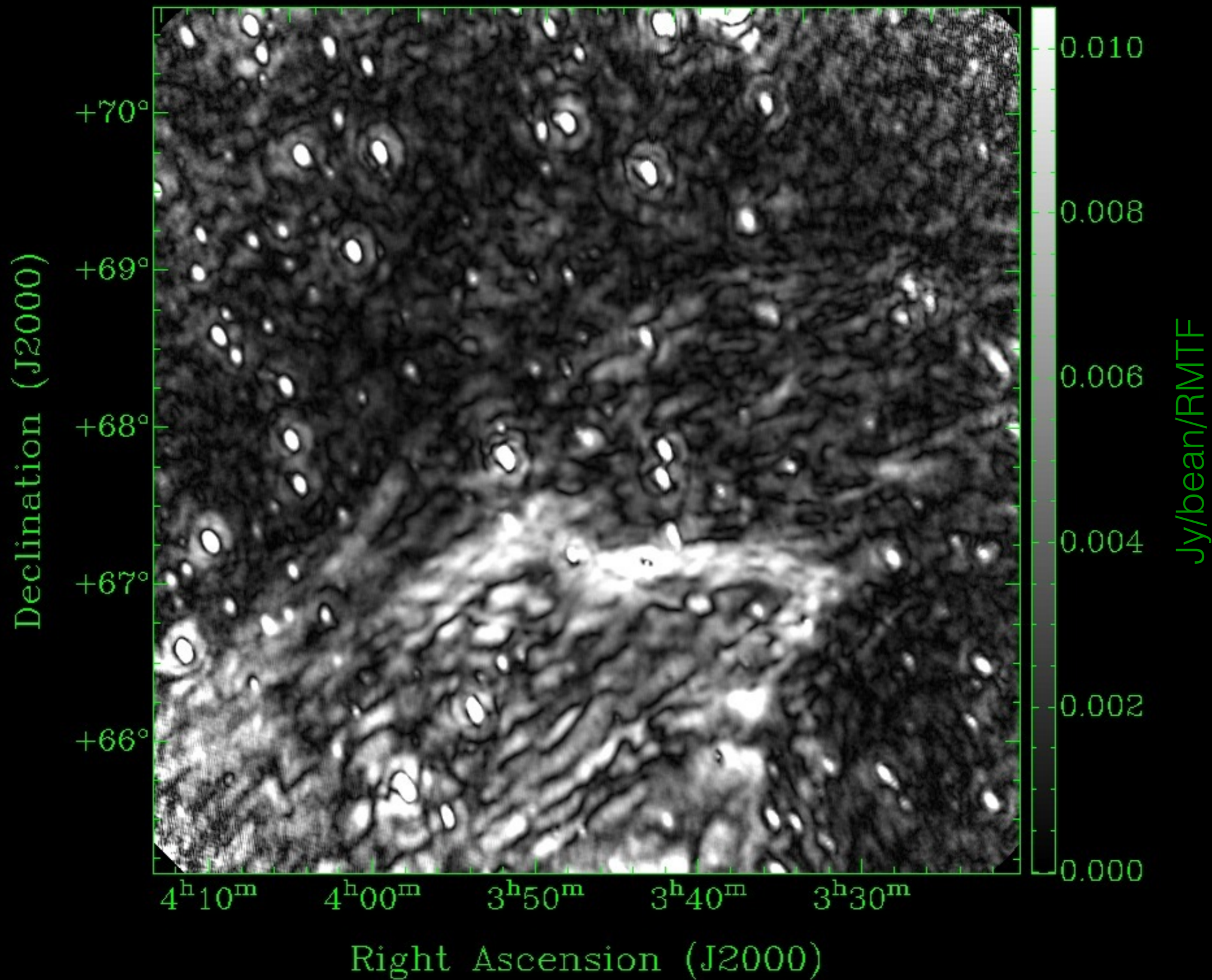
Phi: $-3.500000e+00$



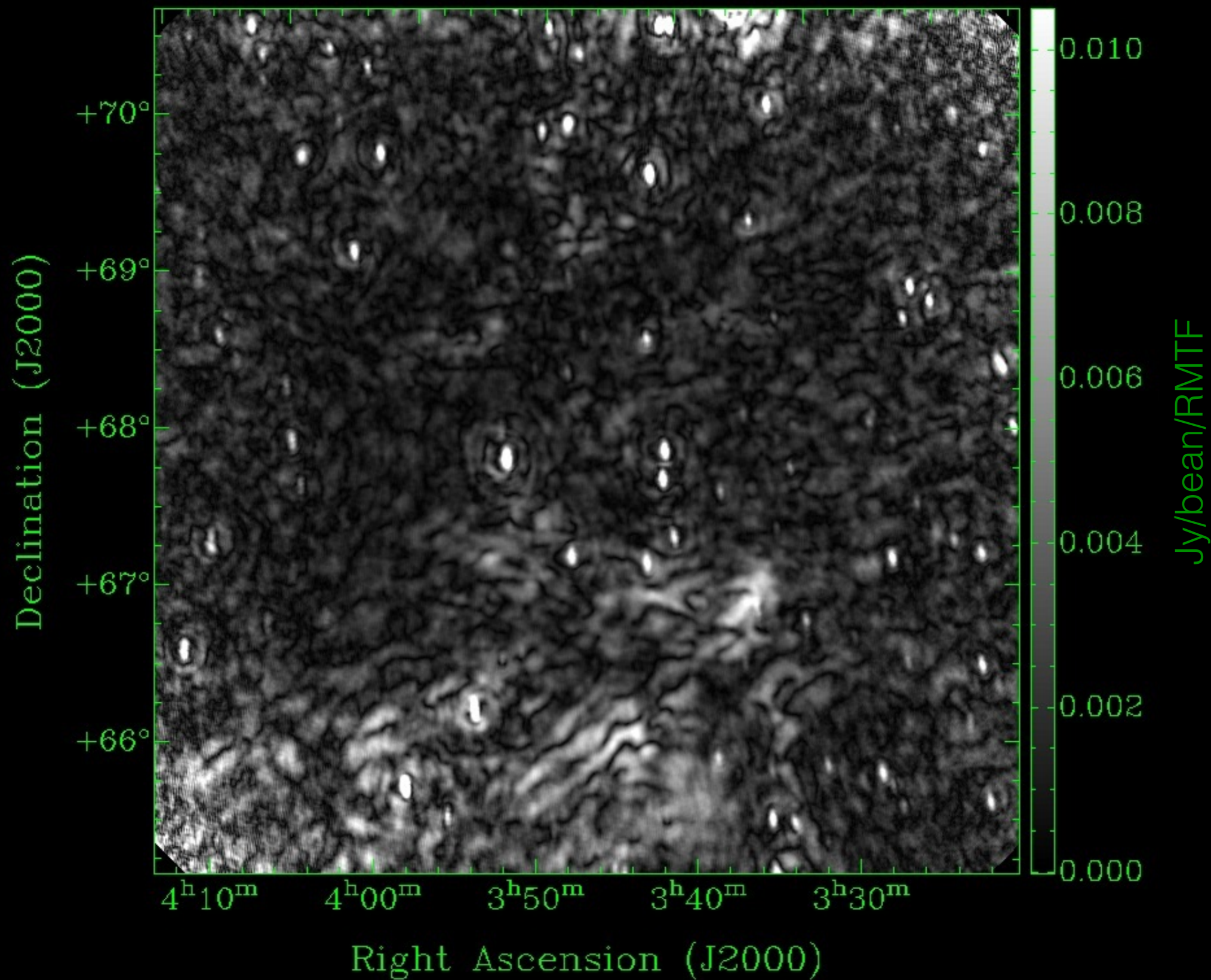
Phi: $-1.500000e+00$



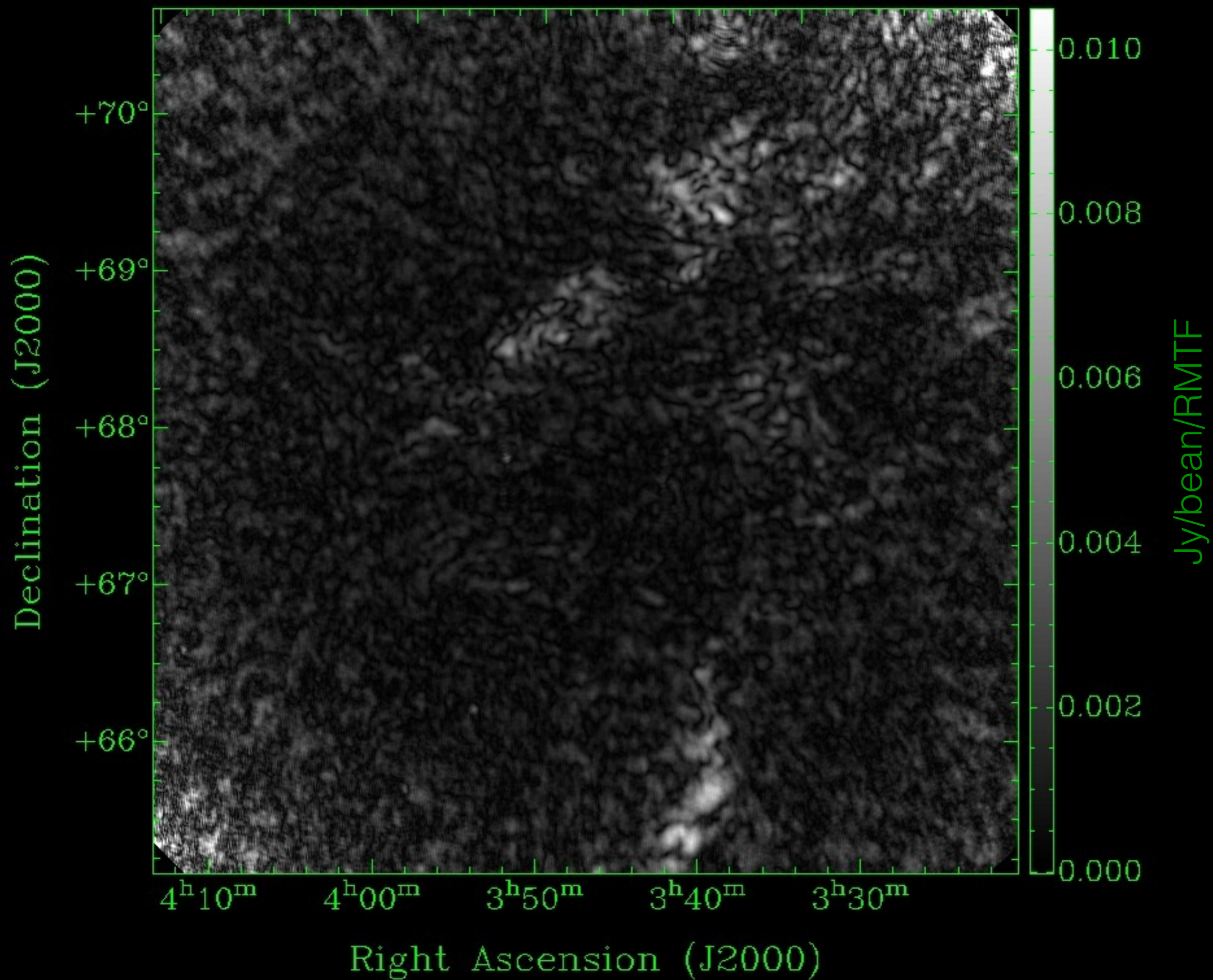
Phi: $-5.000000e-01$



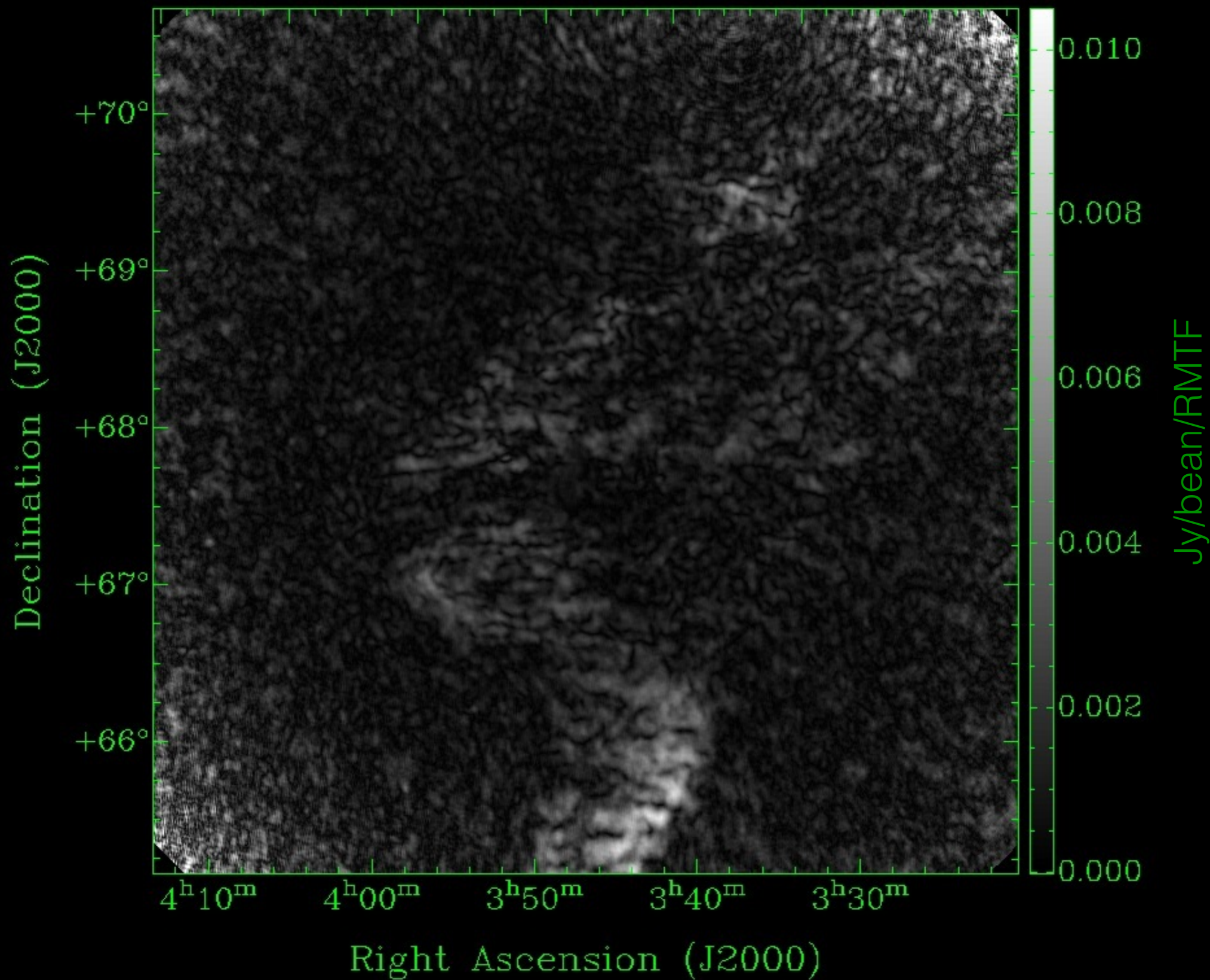
Phi: 5.000000e-01



Phi: 3.000000e+00



Phi: 4.000000e+00

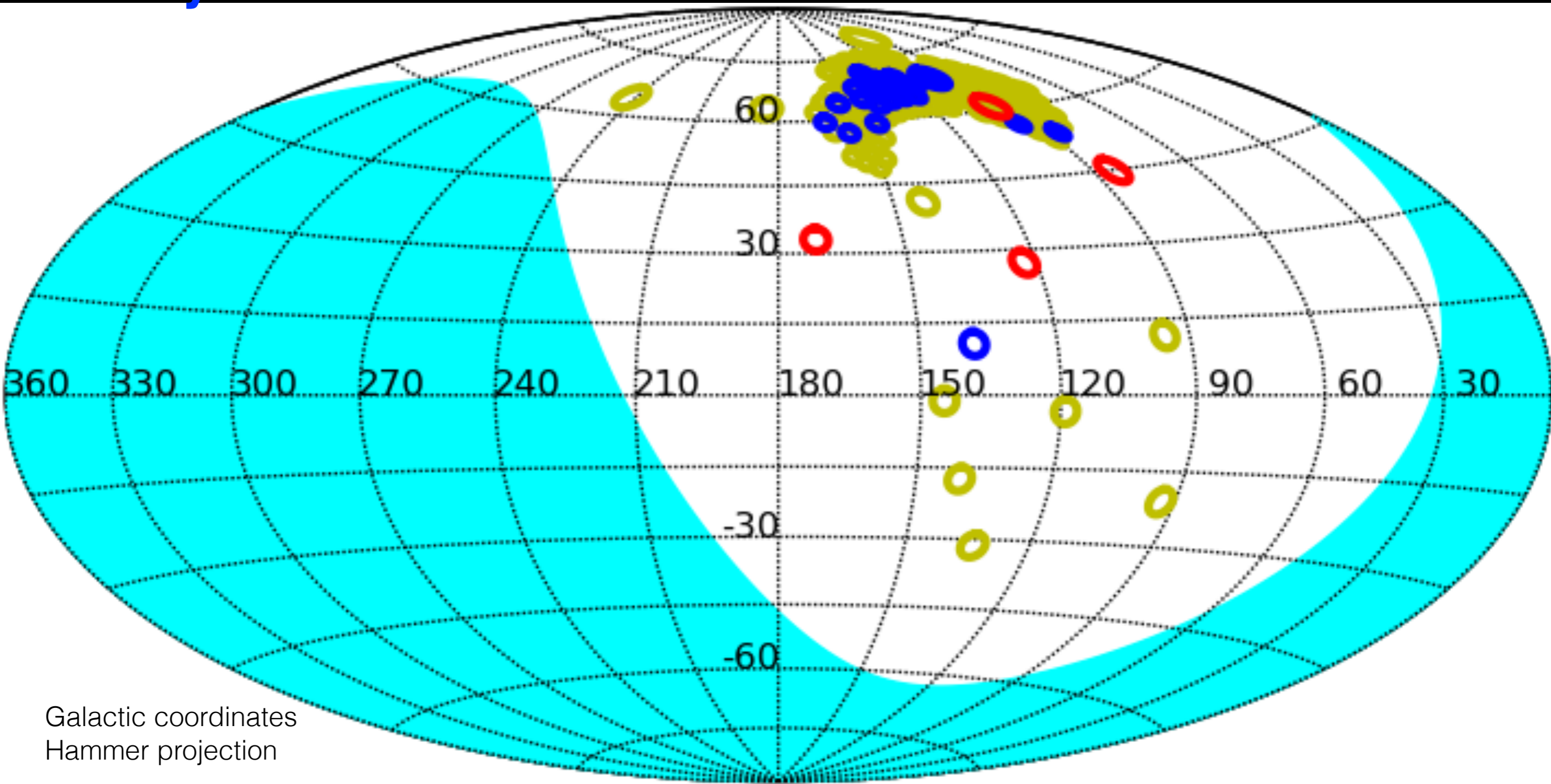


Long term goal

Faraday Cubes made

Tier 1 + MKSP Fields

EoR Fields

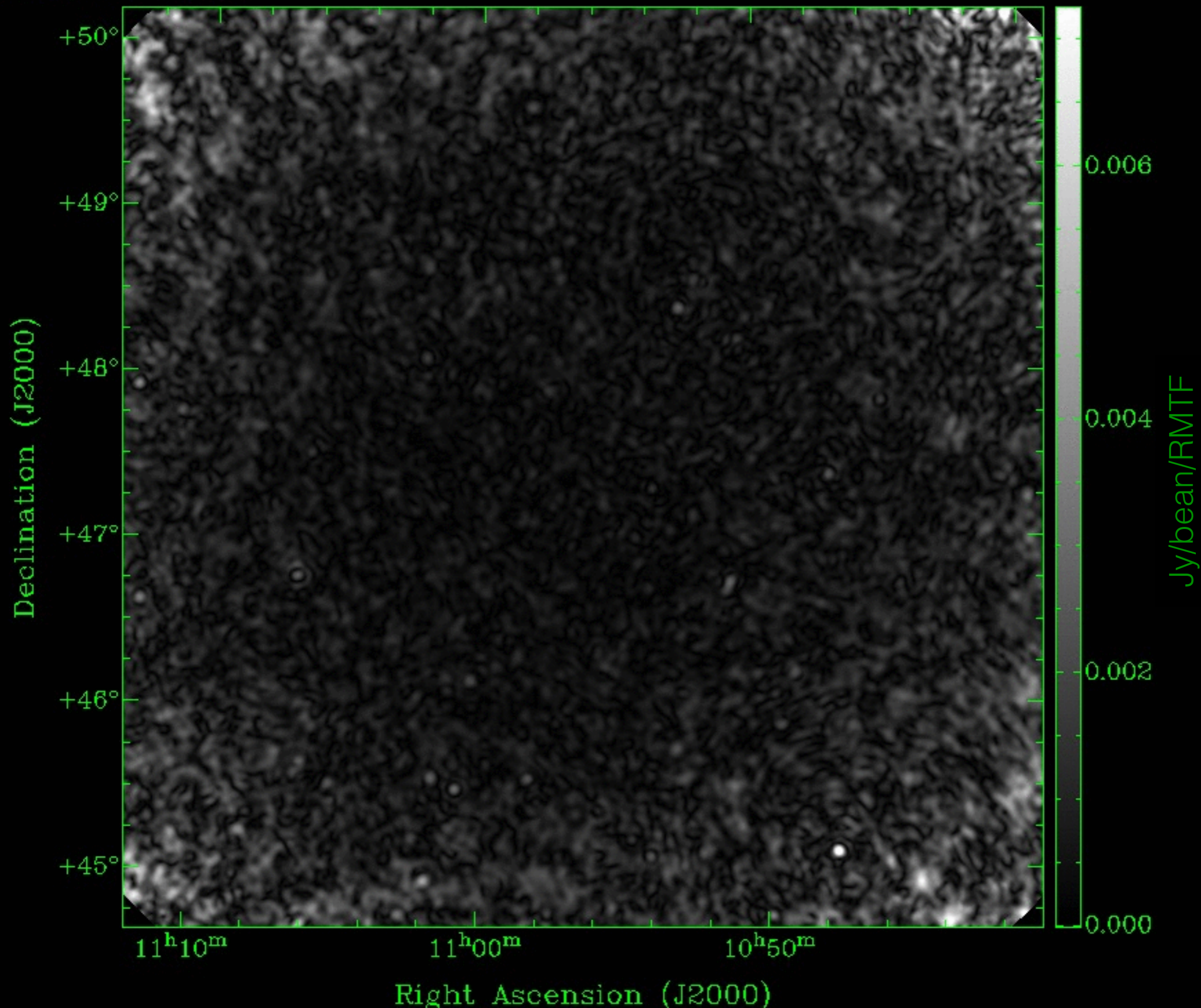


Galactic coordinates
Hammer projection

Summary

- LOFAR gives us unprecedented **sensitivity** and **resolution** at these very low frequencies. Low frequencies, or very long wavelengths, give better **Faraday depth resolution**.
- Faraday tomography gives us a means to probe **complex structures** in diffuse polarization.
- Still to come: **more fields**, models, statistics, etc.

Phi: $-5.000000e+00$



Tier 1 Survey Progress

