Questions and Gain report (PAON4)

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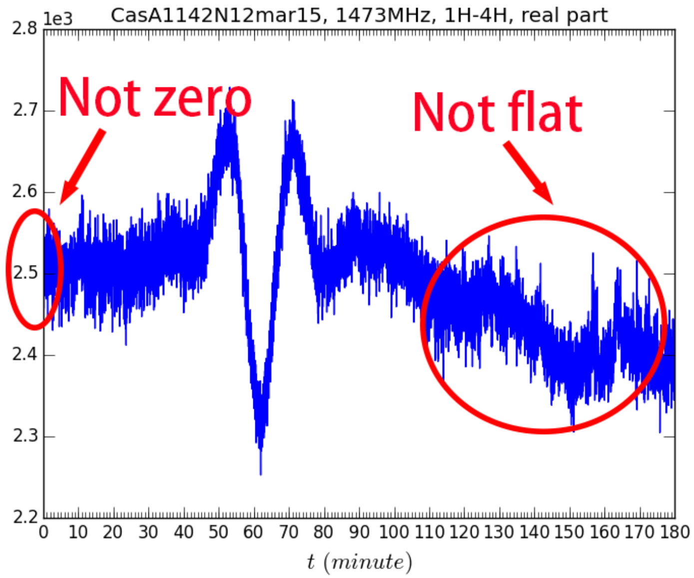
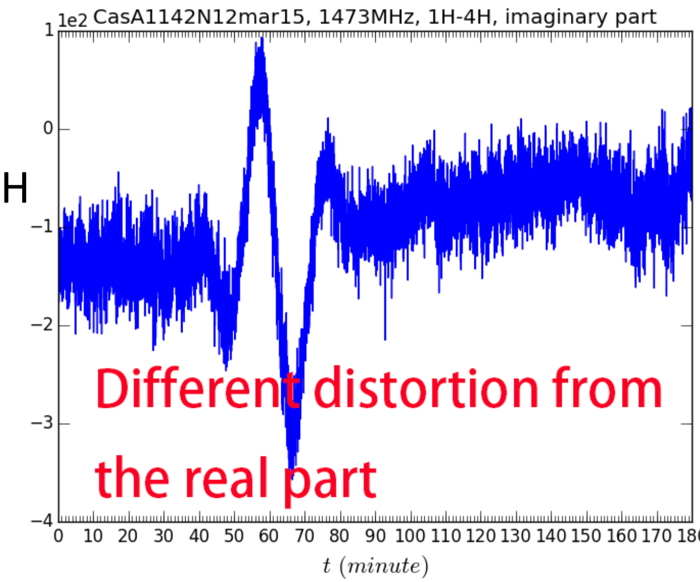
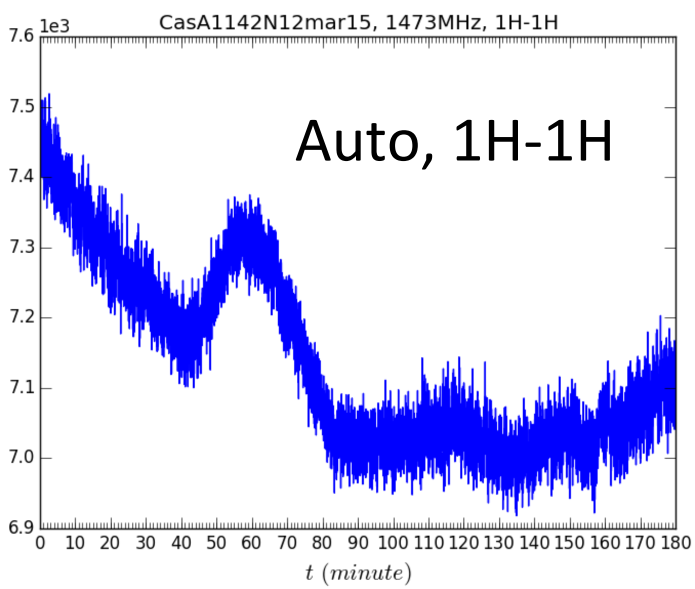
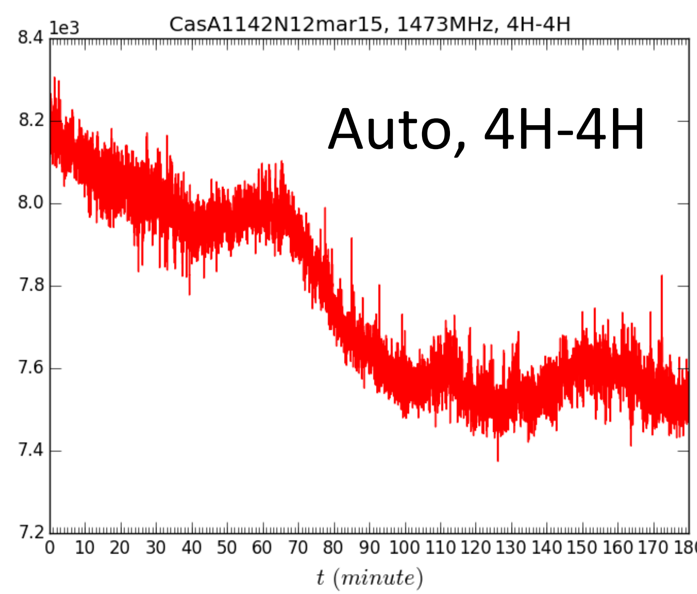
Question about the data



Cross 1H-4H







Gain model

- For a simple model, we decompose the gain into several terms:

$$G(t,\nu) = G_0(t) \cdot g(\nu) \cdot (T_{\rm sky} + T_{\rm sys})$$

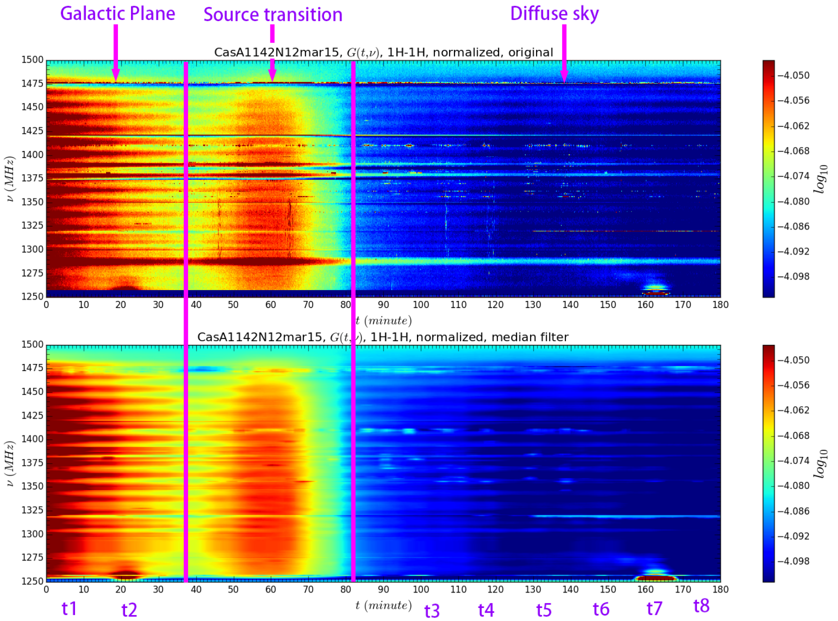
where $G(t,\nu)$ is the auto-correlation converted from arbitrary unit to Kelvin, $G_0(t)$ seems to depend mostly on the environment temperature, $g(\nu)$ is the auto-correlation spectra obtained from the clean part of the data, beyond the bright source and dominated by he receiver noise, $T_{\rm sky}$ and $T_{\rm sys}$ is the sky temperature and system temperature in K.

Auto-correlation

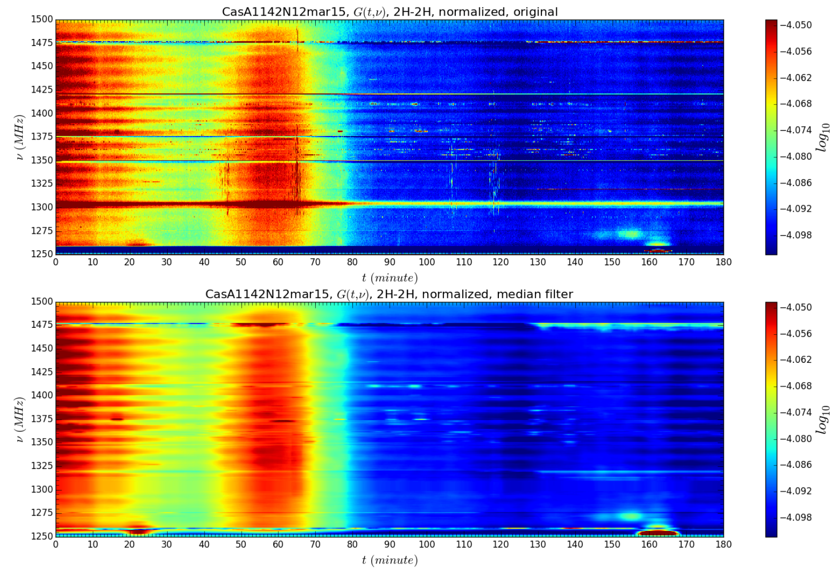
- (1) Use median filter to remove the strong RFI.
- (2) Average the auto-correlation data in 3 minutes to reduce the instrument noise.
- (3) Here I show all 8 auto-correlations. Along the time, we can separate them into 3 parts:
  - Galactic plane, source transition, diffuse sky

Because the gains of each LNA are different, so:

1. Normalized them to 1 so that all auto-correlations have similar scale.
2. Drew them in the logarithm so that we can see the detail clearly.

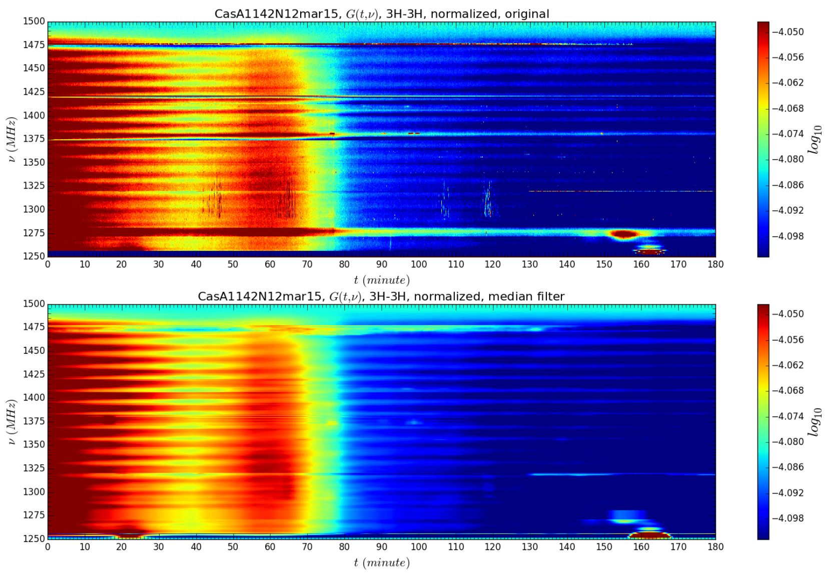


1H-1H

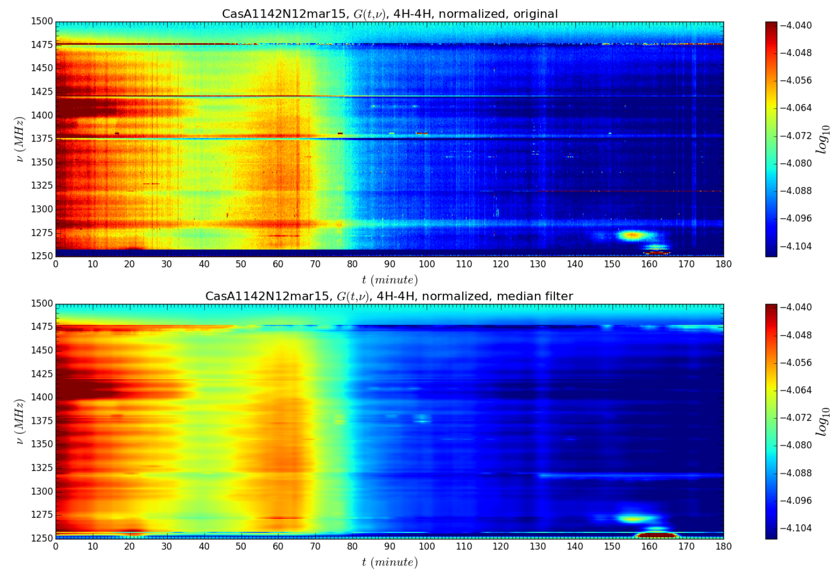


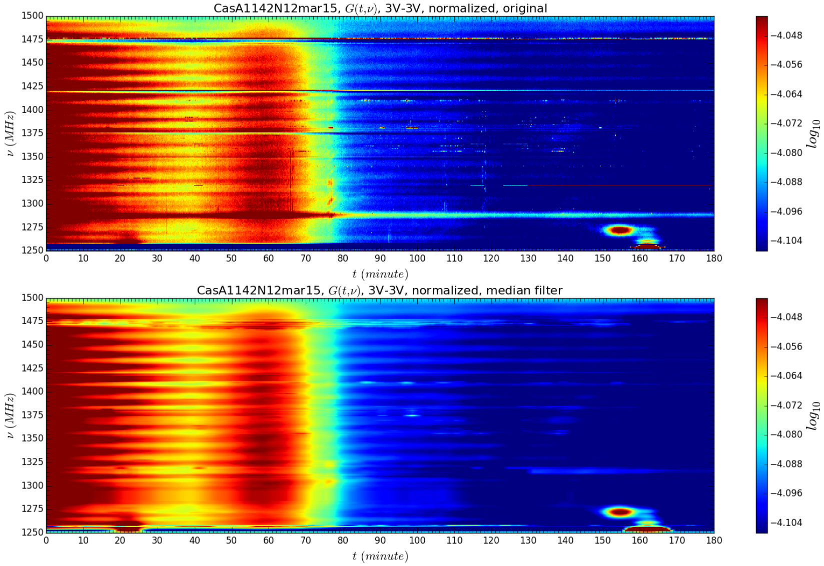
2H-2H

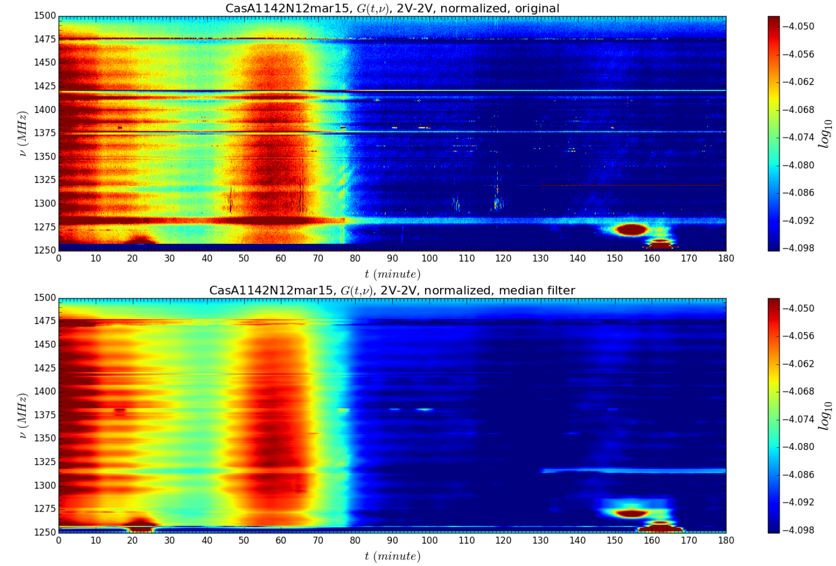
3H-3H



4H-4H





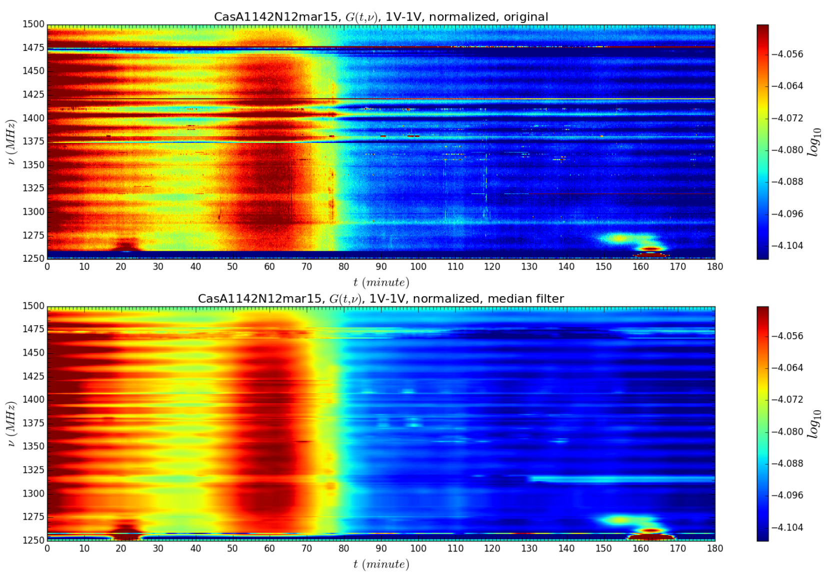


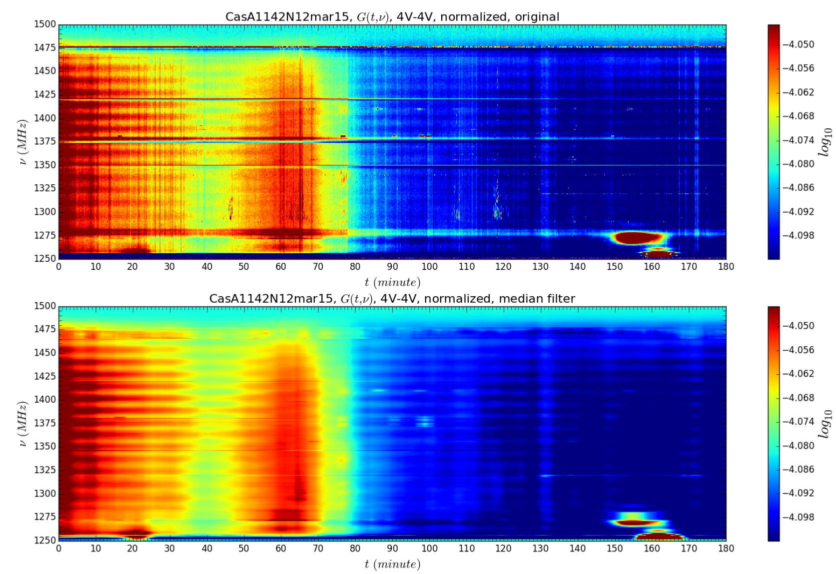
1V-1V

2V-2V

3V-3V

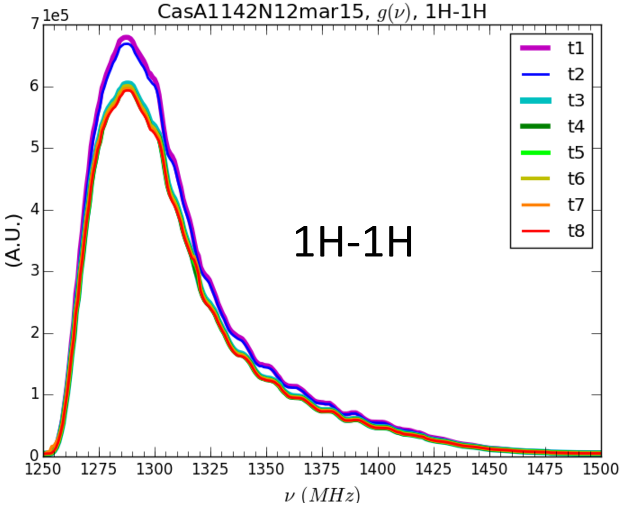
4V-4V



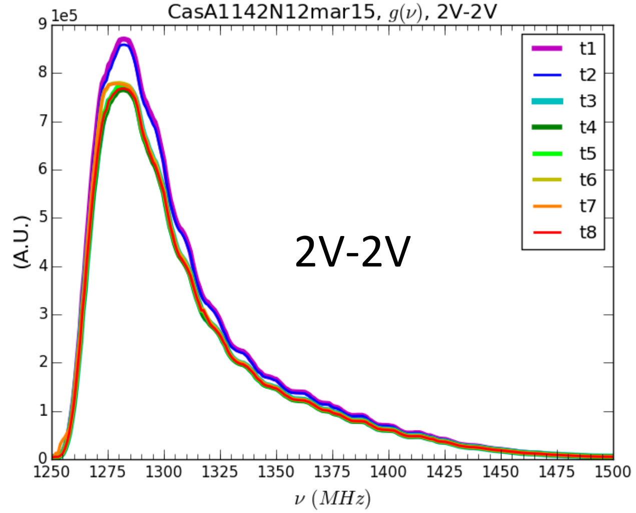


Auto-correlation spectra $g(\nu)$

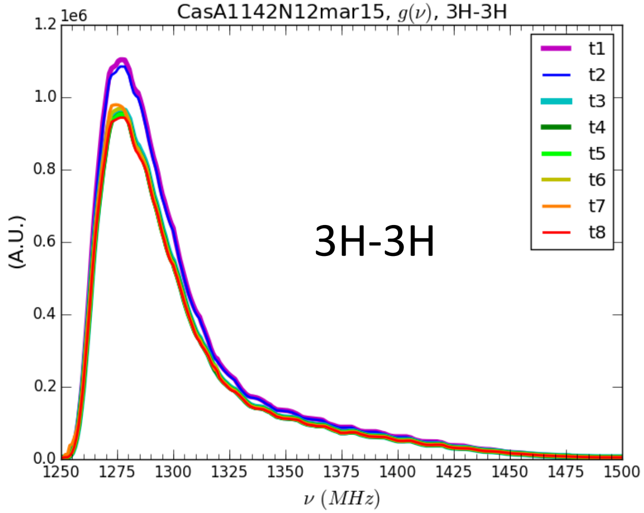
- Plot the spectras of 8 time ranges (t1, t2, t3, t4, t5, t6, t7, t8 in page 4) and compare them



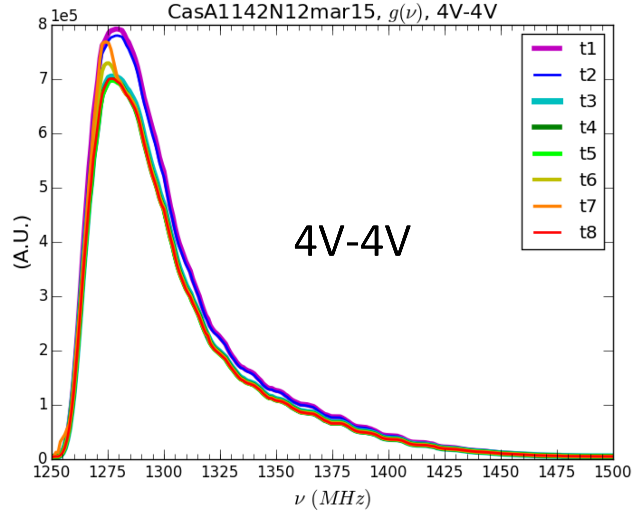
1H-1H



2V-2V



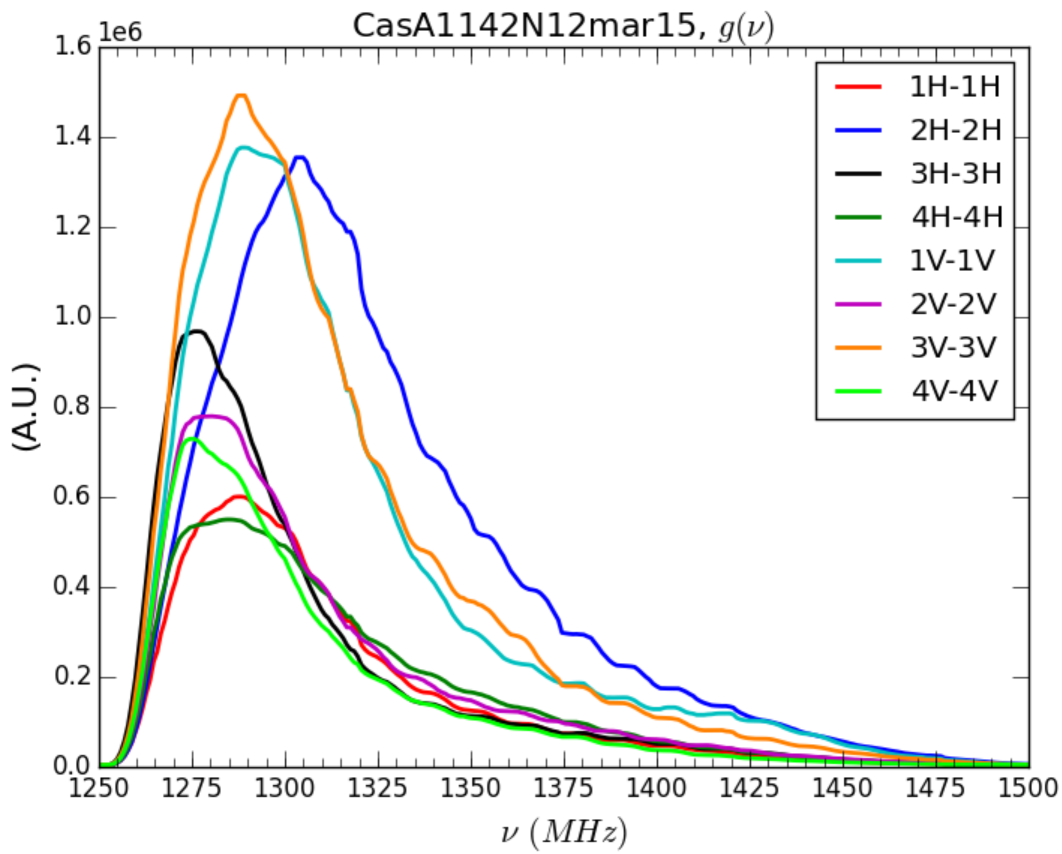
3H-3H



4V-4V

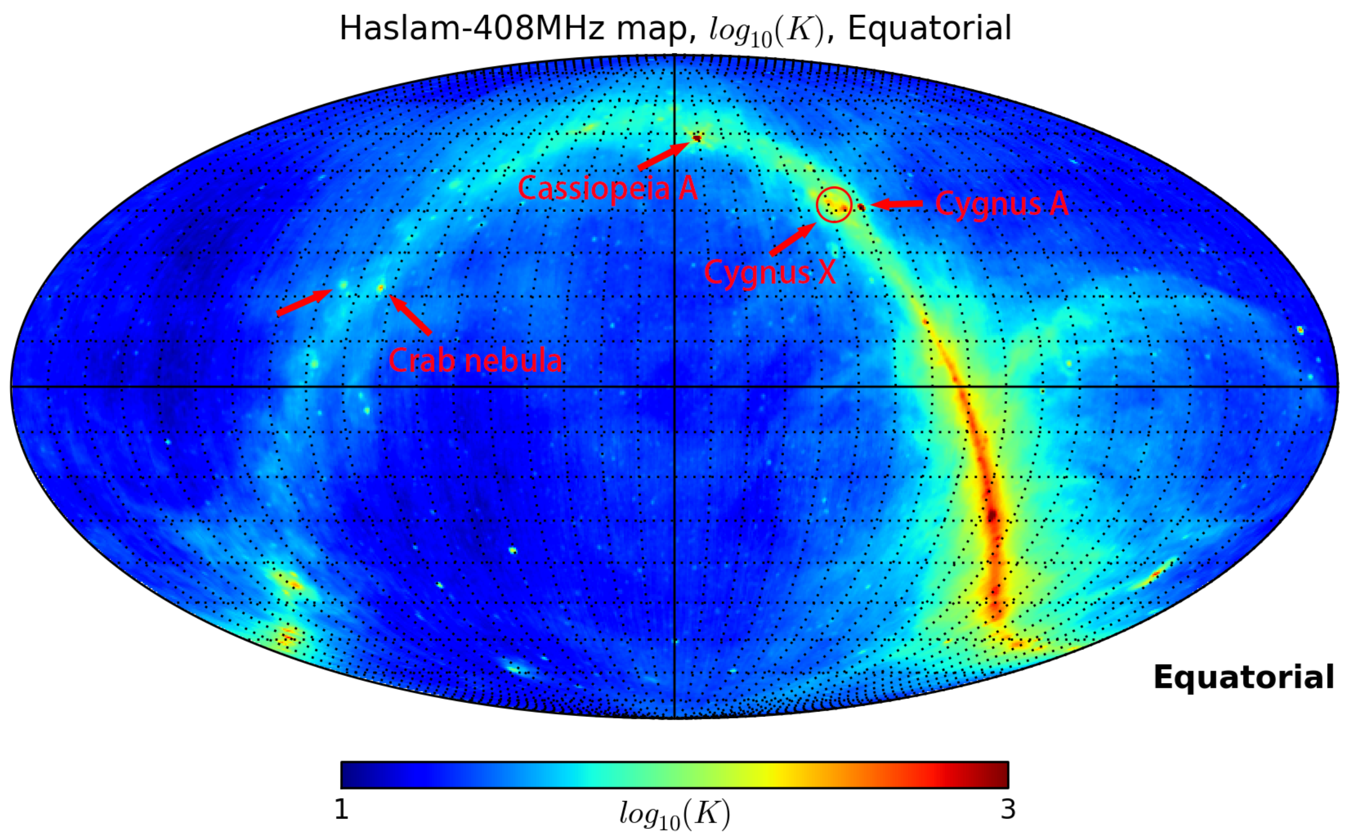
Auto-correlation spectra $g(\nu)$

- We can see that, beyond the bright source (diffuse sky), the gain spectras (t3~t8) stay stable with the time.
- I choose the spectra at t7 as the spectra of the gain.



Sky temperature $T_{\rm sky}$ (1)

- In low frequencies, the strongest component of the background is the Galactic synchrotron emission. Here I use the GSM (Global Sky Model) to predict it. (de Oliveira-Costa et al.(2008))
- Below is the 408MHz Haslam map, that I show it is just to show the 3 target sources of PAON4: Cassiopeia A, Cygnus A, Crab nebule.

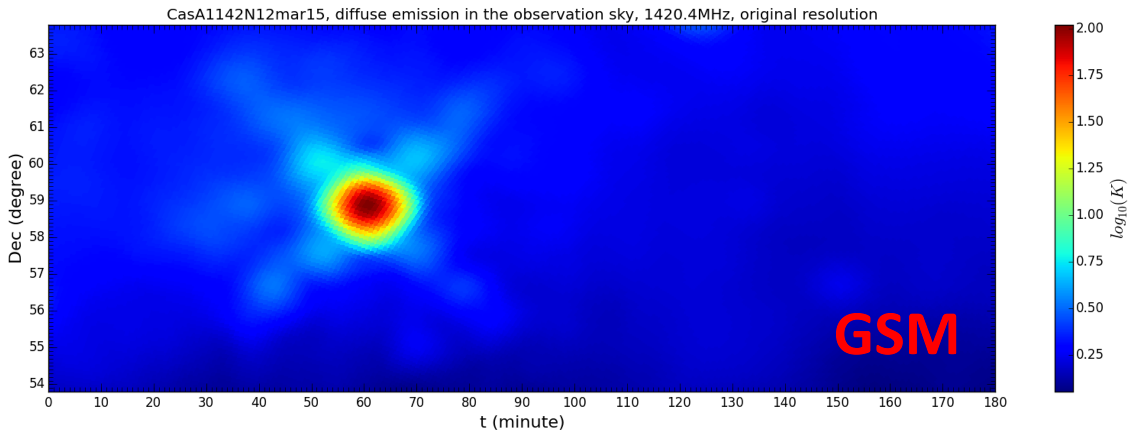


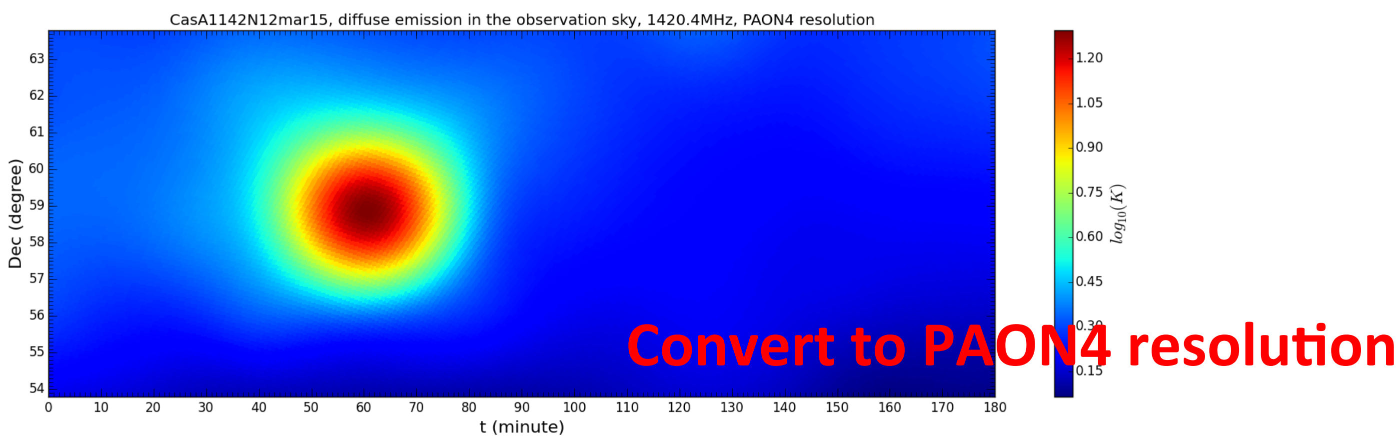
Sky temperature $T_{\rm sky}$ (2)

- FWHM of the PAON4 dish at 1420.4MHz is

$$\sim \frac{\lambda}{D} = 2.42^{\circ}$$

- Cut the sky map around the Cas A ($\mathrm{width} = 4 \cdot \theta_{\rm fwhm}$)





Sky temperature $T_{\rm sky}$ (3)

- Note that CasA is a very bright radio source, in PAON4's resolution at 1420MHz, T(CasA)=20K while the surrounding is about 2-3K (diffuse emission). Therefore, CasA should be a high peak in the transition observation as that shown in page 10.

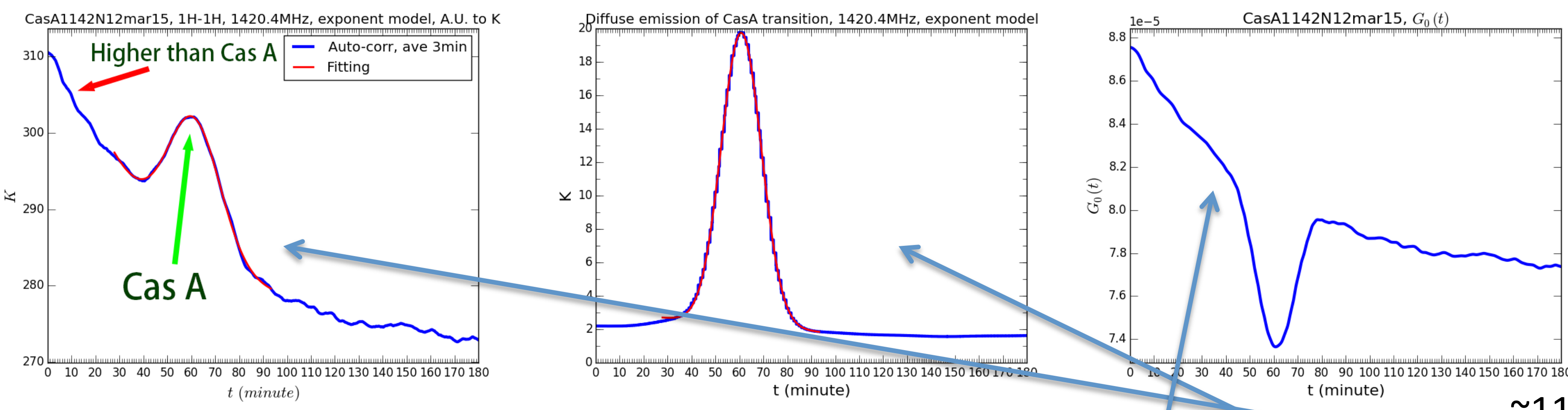
- However, the first part of the auto-correlation is higher than CasA, why? Is it because of the gain/LNA?

$G_0(t)$

Gain model: $G(t,\nu) = G_0(t) \cdot g(\nu) \cdot (T_{\rm sky} + T_{\rm sys})$

Fitting model to convgert A.U. to K
(Obtain the scale of the source, parmeter A):

$$a \cdot \exp\left\{-b \cdot (t-t_0)^2\right\} + A \cdot \exp\left\{-\frac{(t-t_0)^2}{2\sigma^2}\right\}$$



$$G_0(t) = \frac{G(t,\nu)}{g(\nu)\cdot(T_{\rm sky}+T_{\rm sys})}$$

~110K