Overview of PAON4 7 scans map in Dec.

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Gain G_i

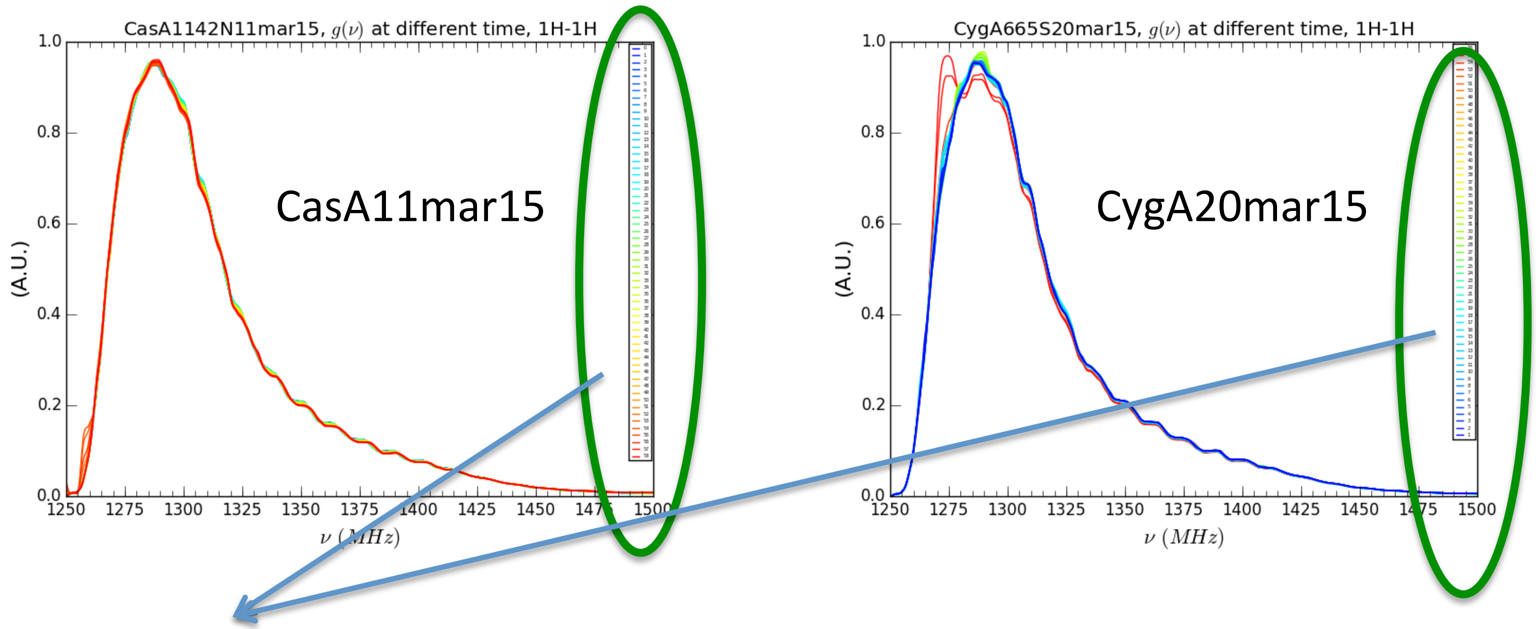
- We assume that the gain can be divide in to two part, one changes with frequency, the other changes with time：

$$G(t,\nu) = G(t) \cdot G(\nu)$$

- We study $G(\nu)$ and $G(t)$ using the auto-correlation.
- $G(\nu)$: assume in a small time interval, $G(t)$ changes a little, then we can get the $G(\nu)$ in this interval by summing/averaging the data.
- $G(t)$: the noise in the data is scaled by the gain $N_{obs} = G \cdot N_0$, if we assume the noise/system temperature is stable, then we can trace $G(t)$ by the standard deviation

Calibrate gain 1: $G(\nu)$

- I calculate the $G(\nu)$ every 5 minutes. Below shows $G(\nu)$ of 2 data set for example, for other data sets on different sources and in different days, the cases are similar.

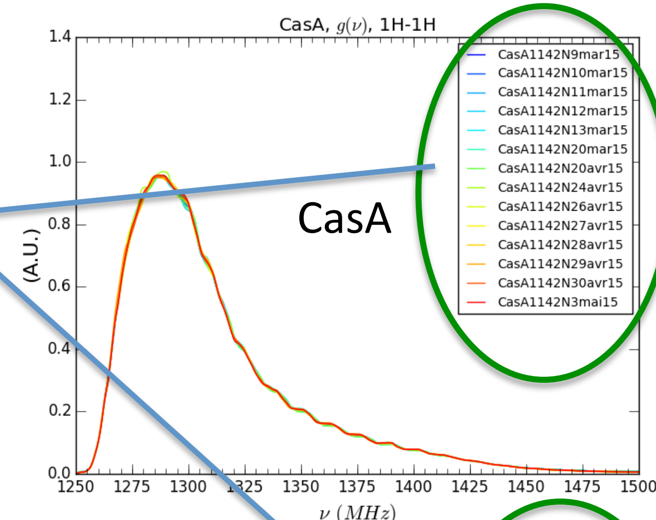


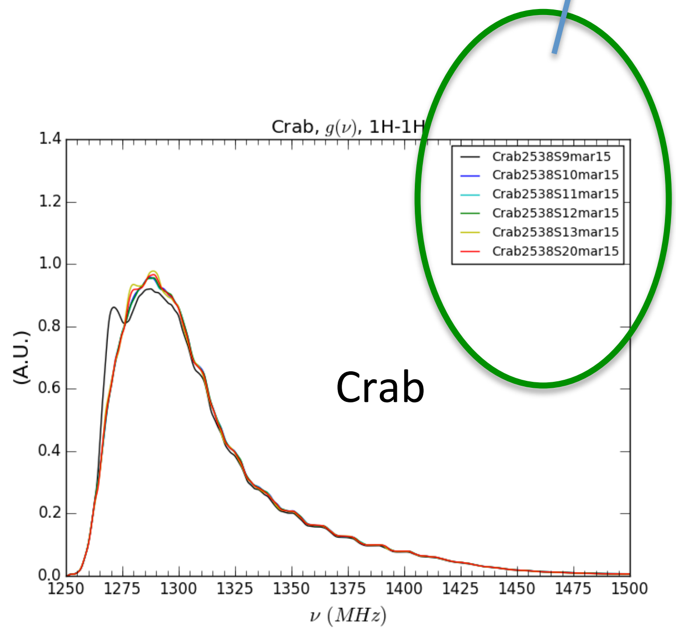
- Note that there are about 50 curves in each figure, and the curves are similar. It means that at least in one day, $G(\nu)$ is stable.

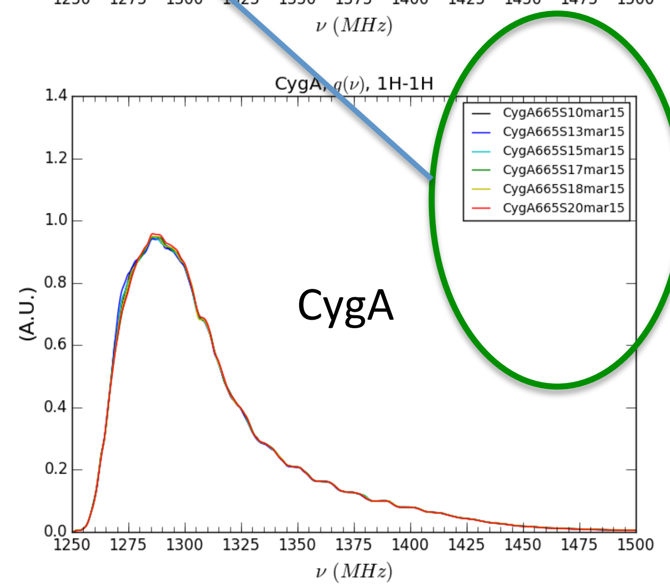
Calibrate gain 1: $G(\nu)$

- Below show the $G(\nu)$ in different days and on different sources.

- We can find that $G(\nu)$ is steal stable.
- Finally, we can consider that, $G(\nu)$ is stable at any time and in any day.

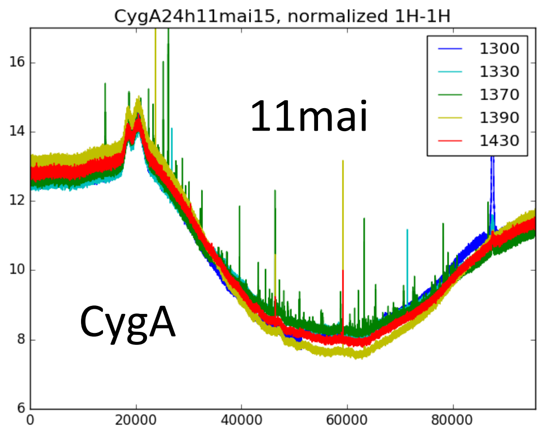




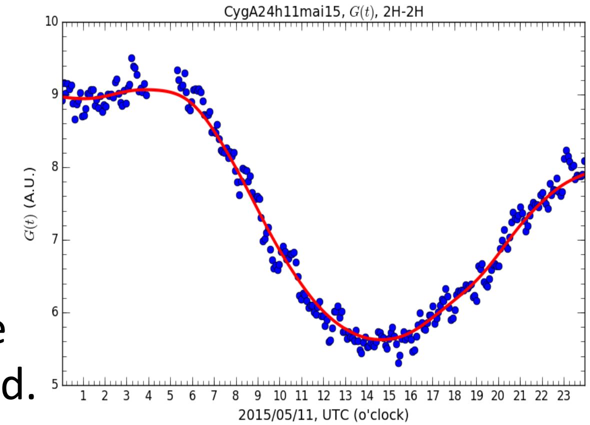


Calibrate gain 2: $G(t)$

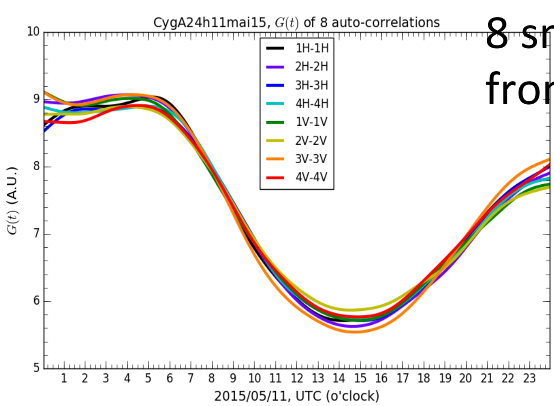
- $G(t)$ will affect the profile of the data along times axis significantly.
- When fit the fringes and make the sky map, we must calibrate $G(t)$ carefully.



8 Auto-correlations
with RFI. I masked the RFI
when calculate std

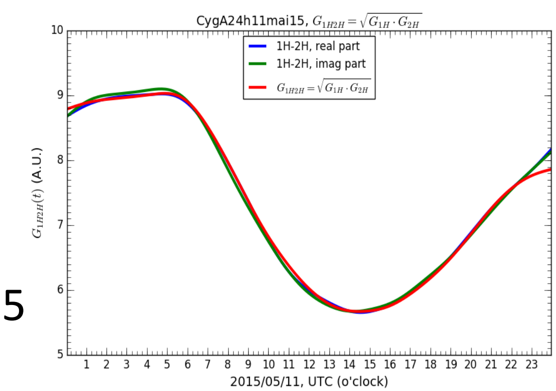


blue points are the
std of data caliculated.
red curve is the smoothing
curve based on the blue points.



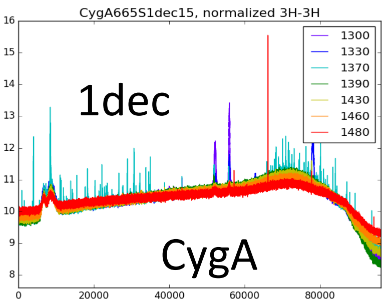
8 smoothing curves
from the blue points.

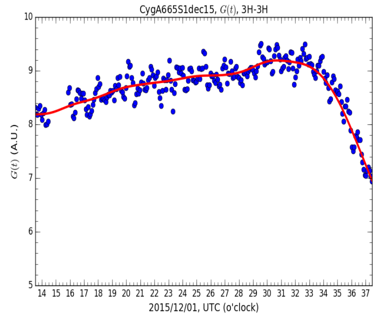
check Gij=(Gi*Gj)^0.5

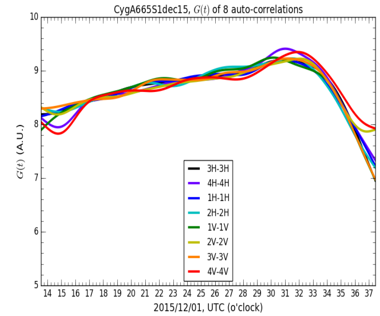


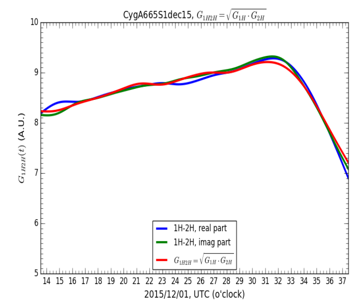
Calibrate gain 2: $G(t)$

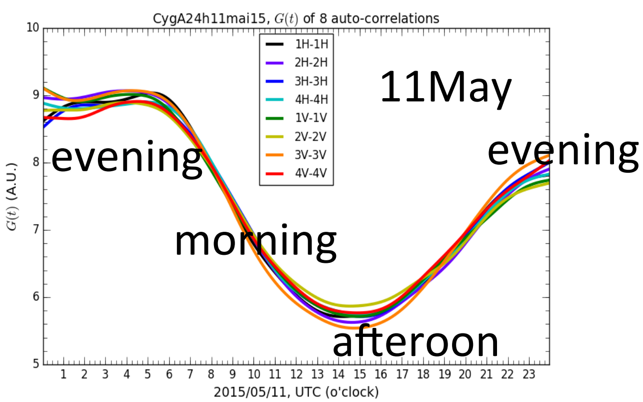
- Same thing but different data set (different day) comparing with the page above.

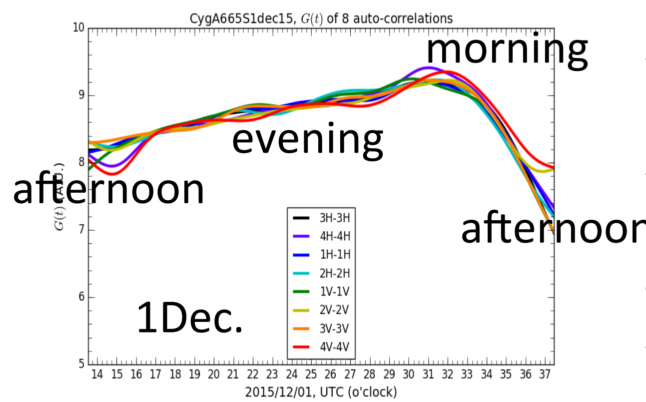












11 May is in mid-late spring, the temperature changes a little large from daytime to night.
While 1 Dec. is in winter, the temperature changes less, then the gain is smoother than that in May.

We can see that, the gain decreases from morning to afternoon, and increases in the evening. Corresponding to the temperature. In higher temperature, gain is lower.

Calibrate phase 1: fit fringe

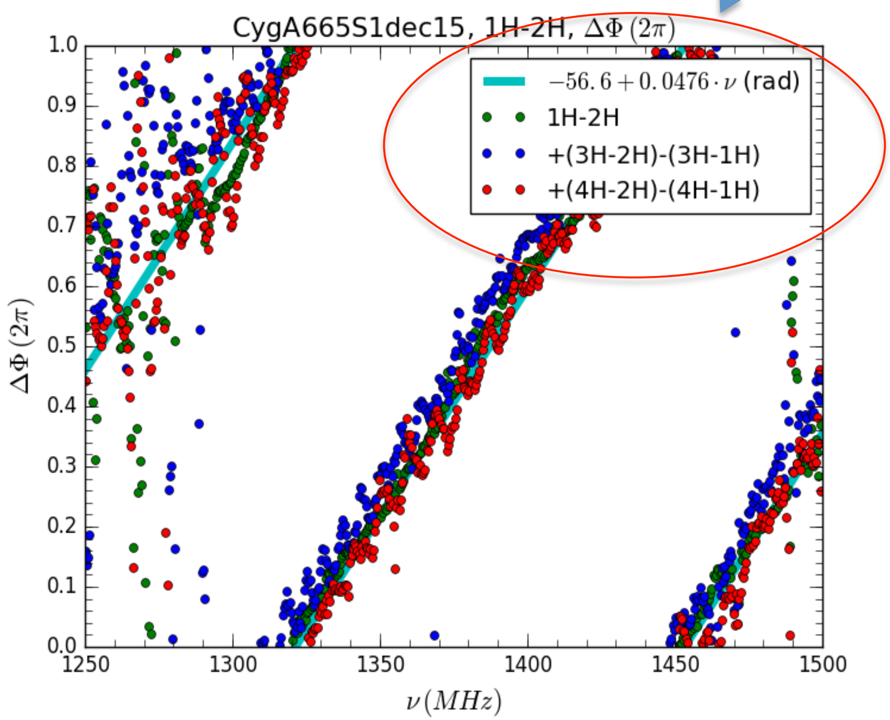
- After calibrating the gain, we can calibrate the phase by fitting the fringe.
- We can see that the phase changes linear with the frequency, then we can fit the linear formula.
- Here I also compare the old data in March and new data in December. something has changed:
- Old data: March ~ August
- New data: November ~ December
- We can find that the phases have changed because we changed something of the instrument, and that affect the new data.

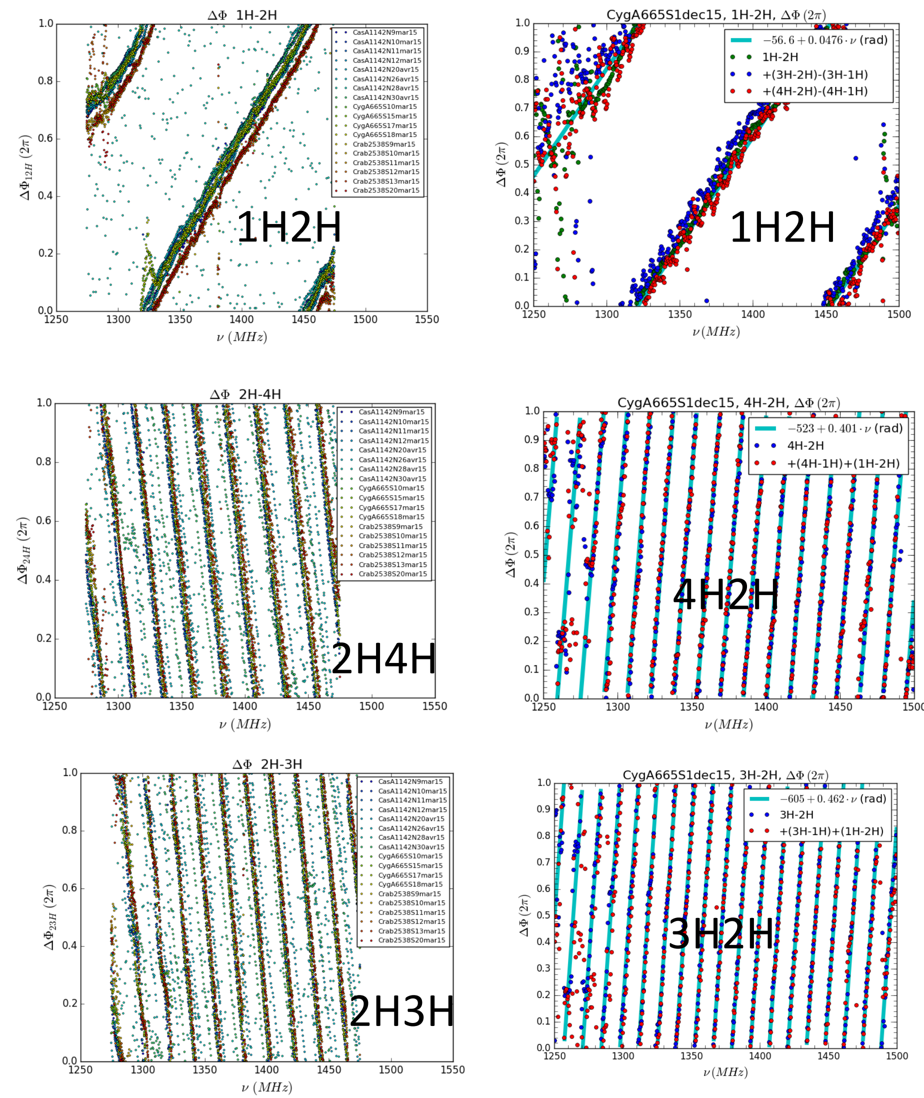
Here I also check the relationship between the phase

$$\boxed{\Delta\Phi_{ij} = \Delta\Phi_{ik} + \Delta\Phi_{kj} = \Delta\Phi_{ik} - \Delta\Phi_{jk} = \Delta\Phi_{kj} - \Delta\Phi_{ki}}$$

It seems the relationship above is reasonable.

and also fit the phase as linear(cyan line)



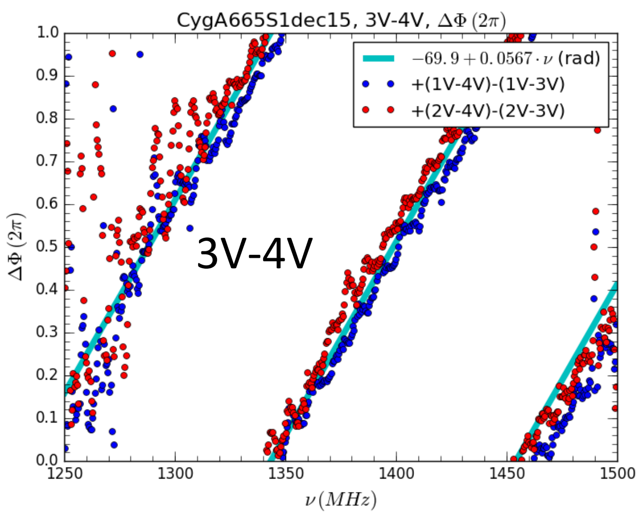


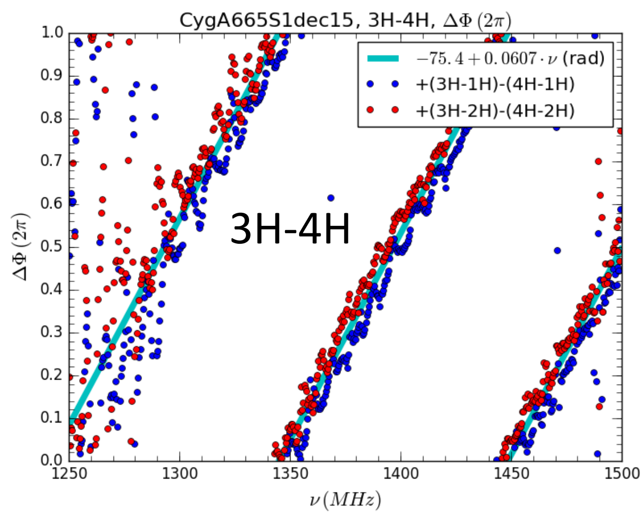
Calibrate phase 2: predict Φ_{34}

- For antenna 3 and 4, the Lew~0, we can't see the fringe and difficult to get phase of 34.
- However, we can use the relationship that we checked above.

$$\Delta\Phi_{ij} = \Delta\Phi_{ik} + \Delta\Phi_{kj} = \Delta\Phi_{ik} - \Delta\Phi_{jk} = \Delta\Phi_{kj} - \Delta\Phi_{ki}$$

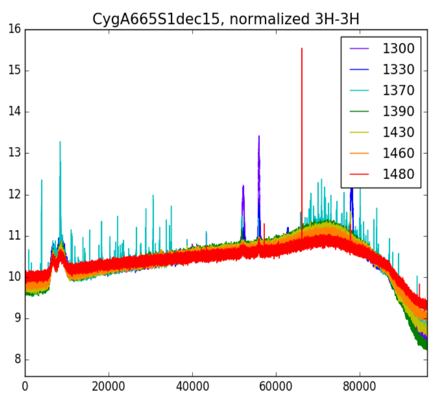
3H4H = 3H1H – 4H1H = 3H2H – 4H2H to predict Φ_{34}, and use this to calibrate the data.



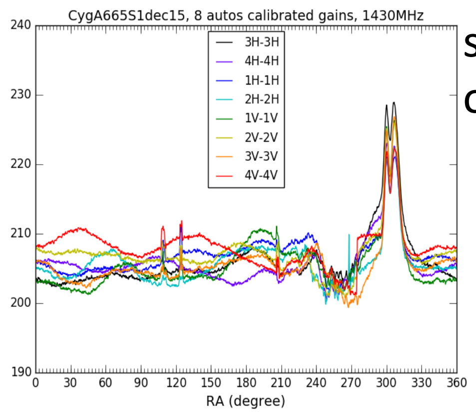


Auto correlations

- After calibrate the gain, all 8 auto-correlations should be more or less the same because they are the power of the sky(assume the system temperature is stable).
- Below We can see 8 auto-correlations are not the same. One reason is that the gain is not calibrated well, the other reason may be the electric system effect.
- In order to convert the observation time to RA, I use the sidereal time that the source reaches the local meridiem. We need to use the RA, Dec of the source and the longitude of the antenna.

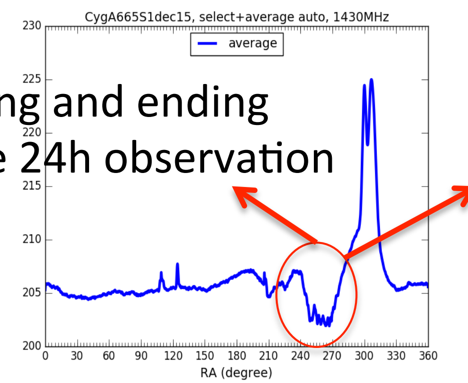


8 auto-correaltions with noise and RFI



calibrate the gain, remove the RFI, lower the noise

starting and ending of the 24h observation



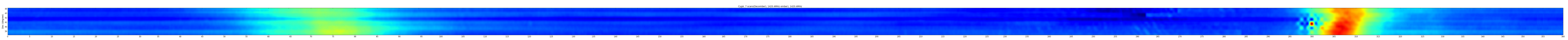
Because of the uncertain/bad edge of G(t)

The auto-correlationof 2H, 1V, 4V are not good, I throw them, and average the rest

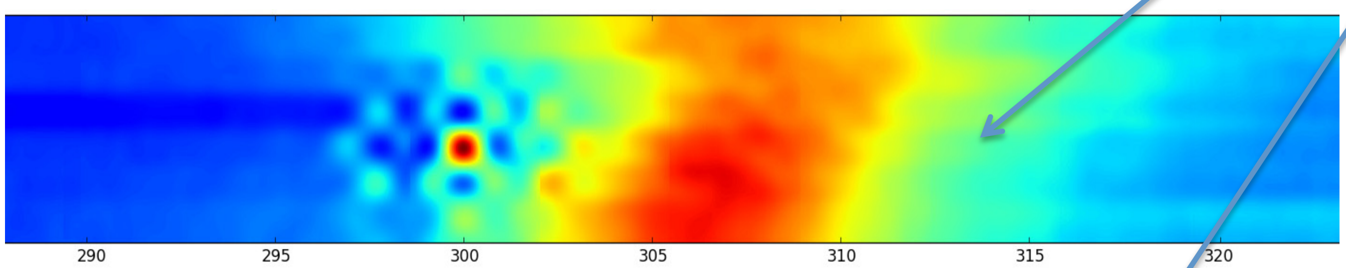
Make map

I use 7 scans to make this map.
For each scan, I get 200 mock lines by add a phase exp(i*2pi/l*Lns*sin(delta)),
delta=1 degree for 200 pixel.

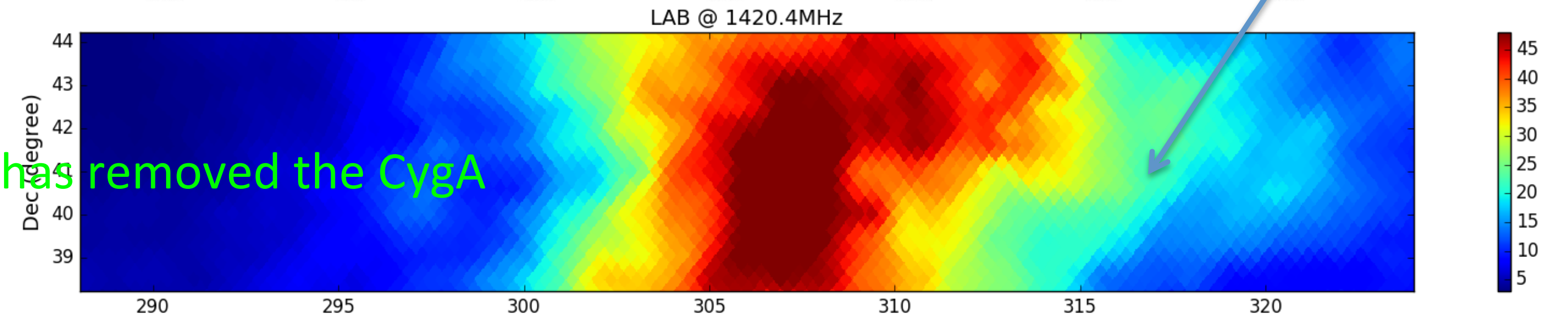
7dx360d, 1420.4MHz (you also find the large image in .jpe)



The same sky region of LAB data



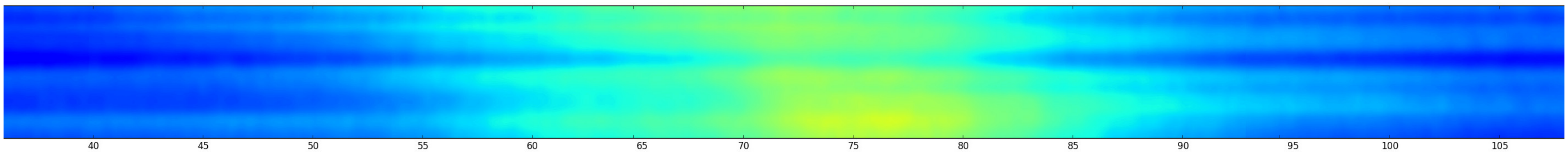
1420.4MHz



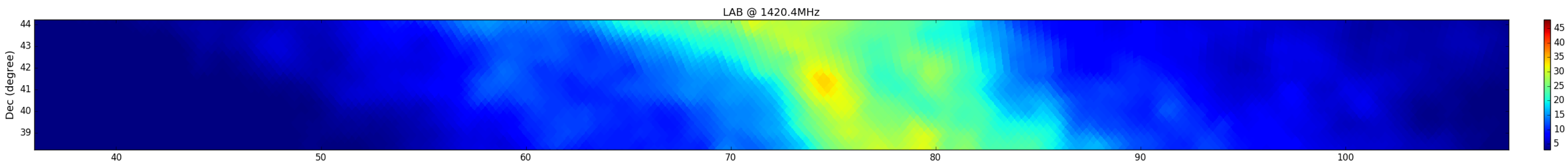
LAB has removed the CygA

Make map

PAON4, galactic anticenter, 1420.4MHz



LAB, galactic anticenter, 1420.4MHz



When we observe the CygA, we will usually see two peak, one is the CygA, the other is the so called Cygnus X.
I make the map at 1422MHz where HI emission is weak, we can see the structure of the Cygnus X.