PAON-4
Analysis update & Paper I
(PAON4 design & Operation)

R. Ansari, O. Perdereau, J.E. Campage)

July 2019

- Analysis of Nov 2016 data in Q. Huang PhD dissertation (Chapter 6) - Defence October 2019 (18 Oct 2019)

- Some recent progress on better understanding of instrument behaviour : noise, pointing, phase and gain stability

- Analysis of data taken in Summer 2018, Fall 2018, Winter 2019, Spring & summer 2019, about ~ 60 x 24 hours data, covering declination range from 12 deg to 60 deg

- A first Paper, PAON4 design and operation (Paper-I) being written, with some figures about instrument performance - Planned to be submitted before or early September

- A second paper (Paper-II) will probably follow (+6 months ?) with some more detail about the data analysis and with some reconstructed maps …

Design and operation of the PAON4 prototype Intensity Mapping instrument

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PAON4 is a wide L-band (1250-1500 MHz) small interferometer operating in transit mode deployed at the Nançay observatory in France, designed as a prototype instrument for Intensity Mapping instruments. It features four 5 meter diameter dishes in a compact triangular configuration, equipped with dual polarisation receivers, representing a total collecting area of $\sim 75\text{m}^2$. The $4 \times 2 = 8$ independent RF signals are amplified, filtered and digitized by the BAORadio analogue and digital electronic chain, before being fed to the associated software correlator which compute the 36 visibilities, over the full 250 MHz band. The array operates in transit mode, the dishes point to a fixed declination, while the sky drifts in front of the instrument. The sky maps for each frequency channel are reconstructed by combining the time-dependent visibilities from the different baselines. This paper presents an overview of the PAON4 instrument design and goals, as a prototype for dish arrays to map the Large Scale Structure in radio, using the atomic hydrogen 21 cm line through the intensity mapping. We discuss also the operation mode and observation strategy carried so far, as well as instrument performance and some preliminary results.

Close link to Tianlai

Title not yet final, might change to

Design and operation of the PAON4 prototype transit interferometer

Journal not yet selected , MNRAS ? AJ (The Astronomical Journal) ?

Would be wise to target the same journal

Qizhi Huang

Supervisor: Prof. Réza Ansari

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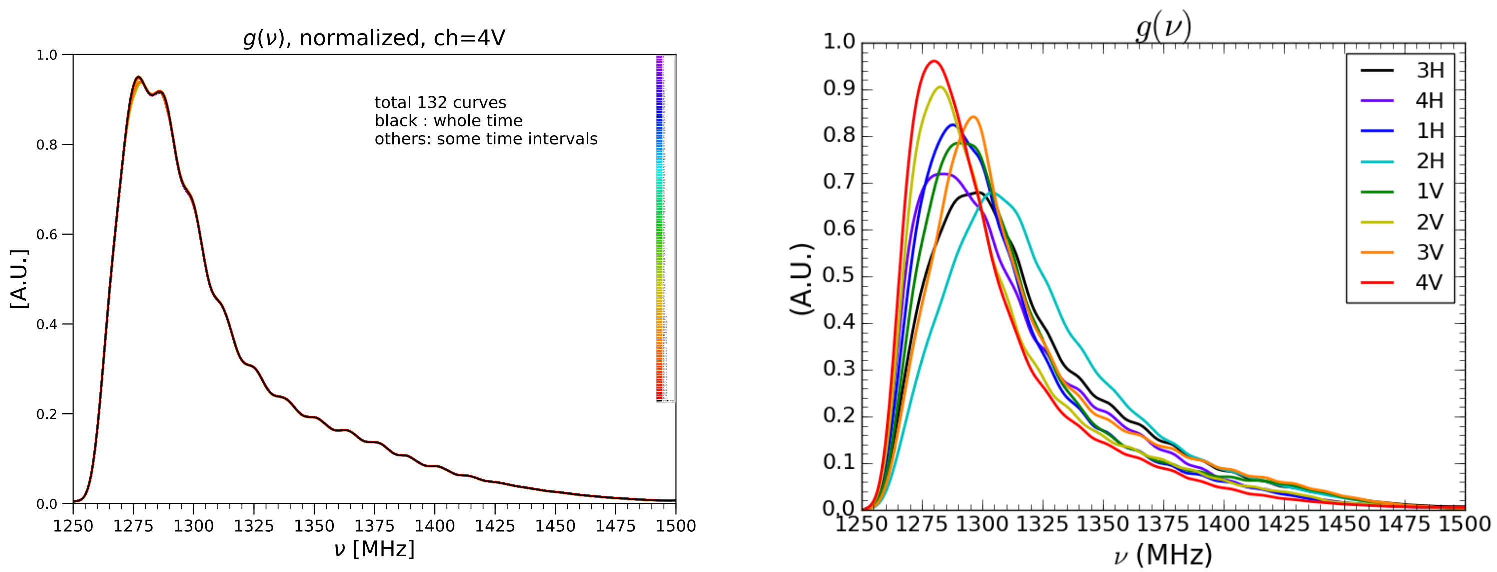
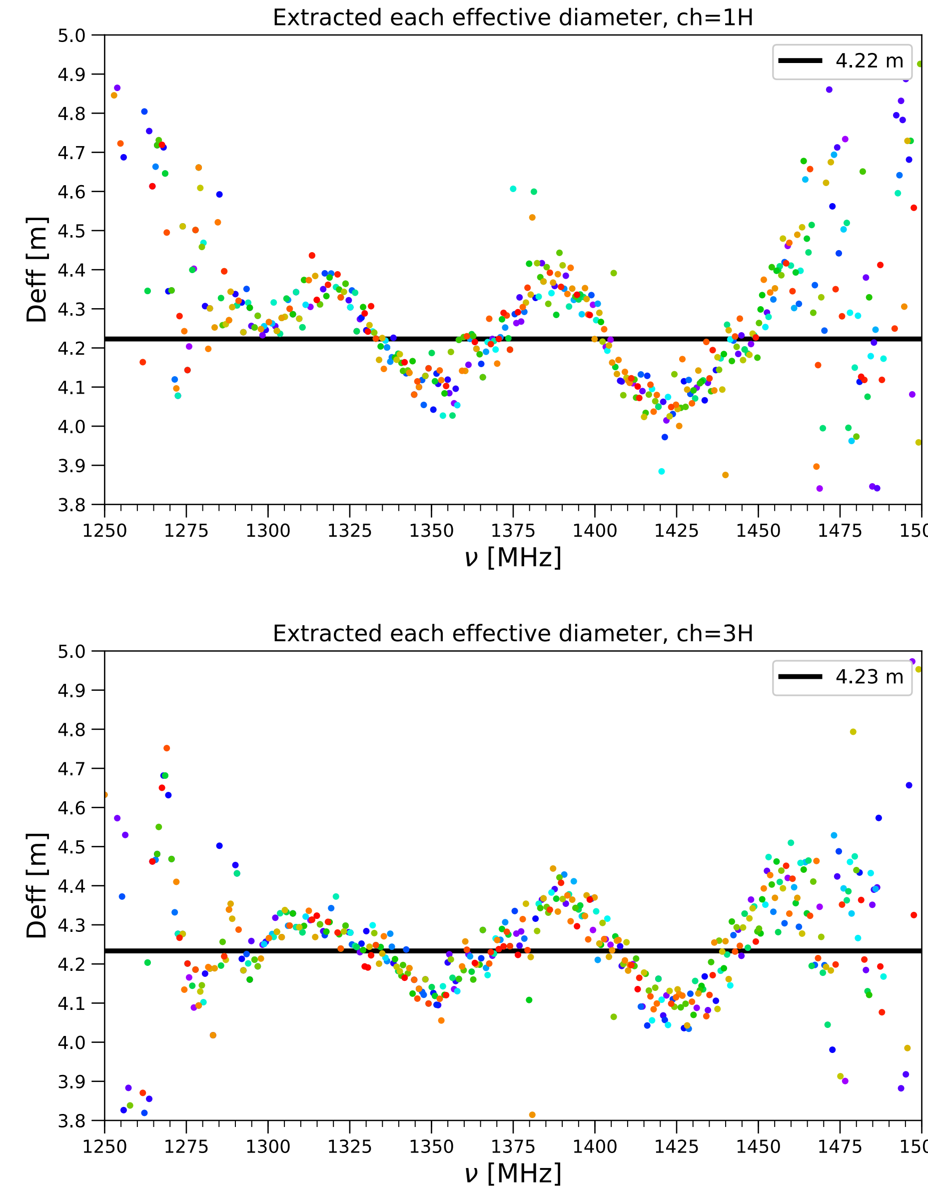


Fig. 6.7 The stability of $g(\nu)$ over time. The total period of time is split into 131 intervals, $g(\nu)$ in each time intervals varies little, its satbility is reasonable high. Colorful curves are for the 131 intervals, black curve is for the whole period of time. For other channels with different hardwares, the specific $g(\nu)$s are different (right column).

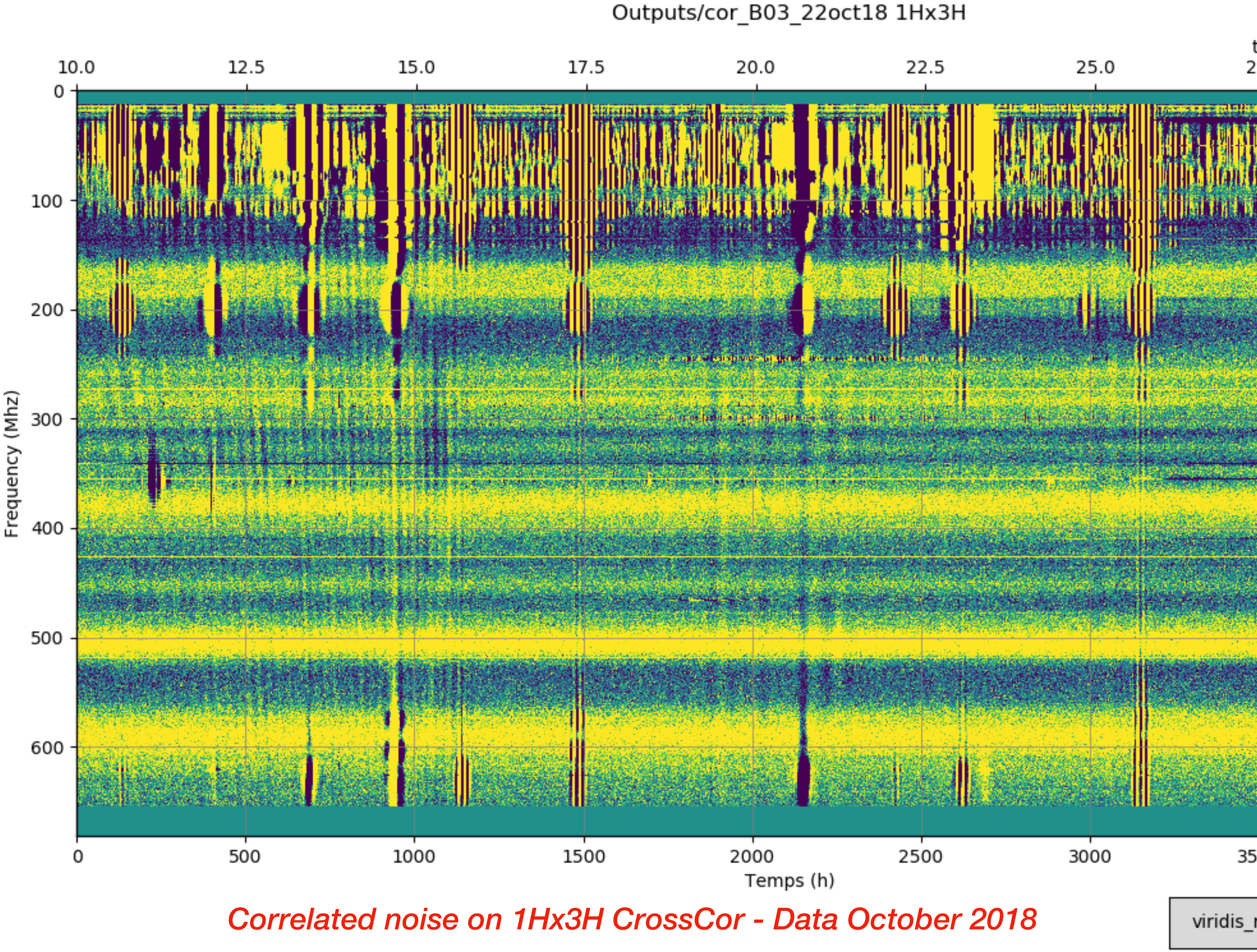


Effective dish diameter - standing waves feed-reflector

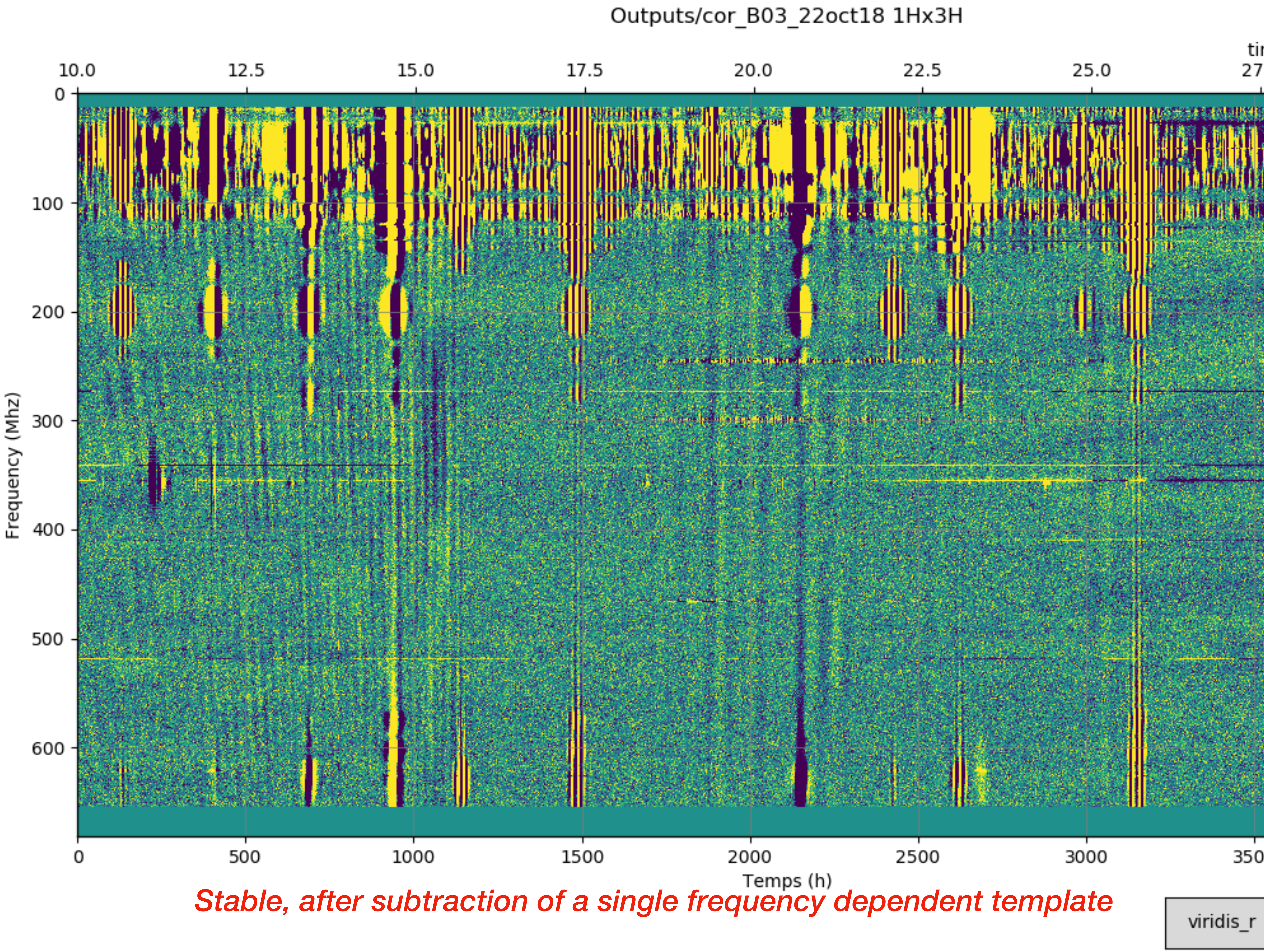
Q. Huang PhD dissertation

from Chapter 6 (PAON4 Fall 2016 data analysis)

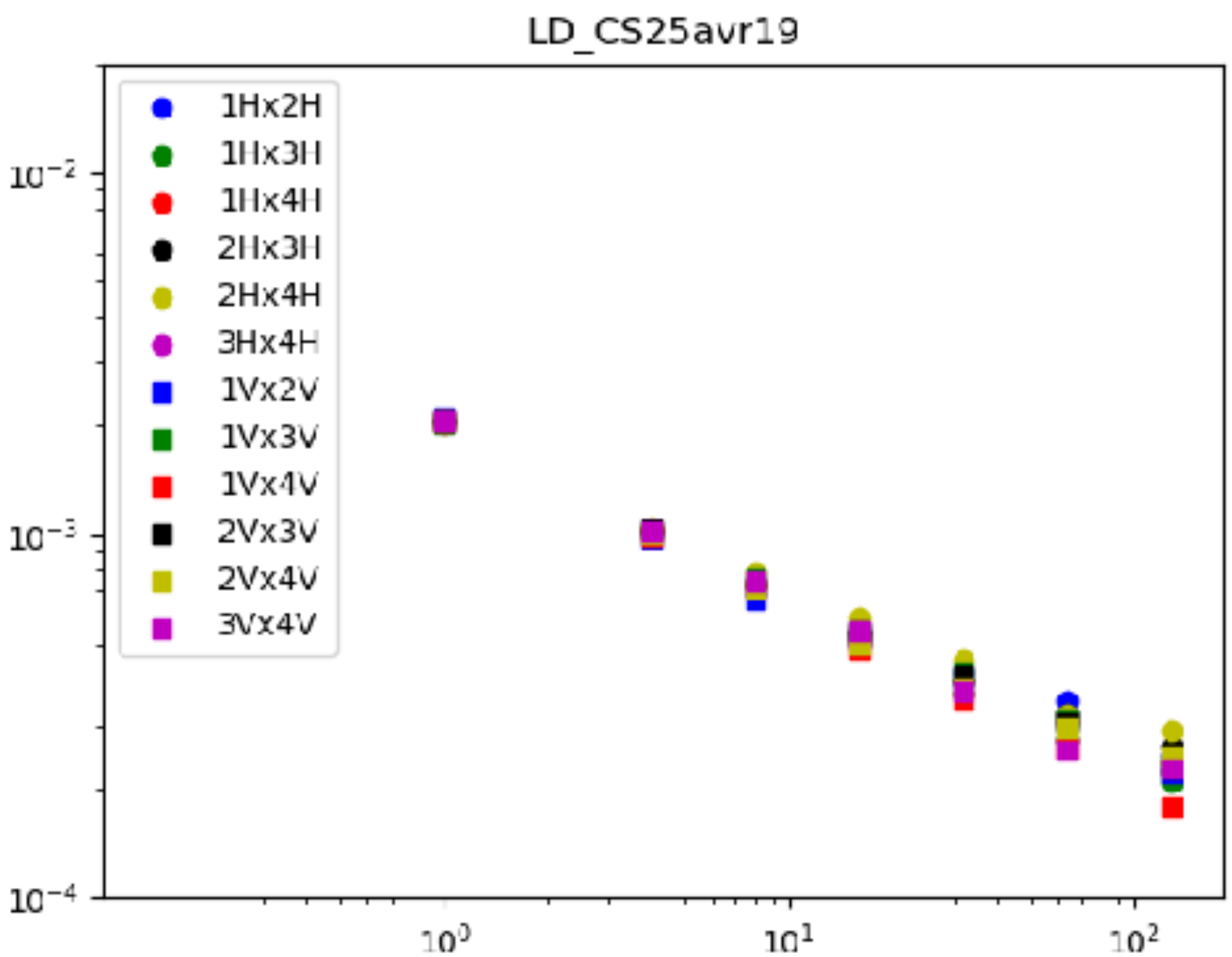
- Study of phase stability over few months (from Galileo satellite transits)
- determination of positions offset along Z axis (vertical) and Y axis (NS) using observations spanning nearly 50 degrees in elevation
- Study of noise behaviour on auto & cross correlations
- Tsys ~ 100-120 K after calibration on CasA and CygA (compatible calibration)
- Noise level on auto and cross-correlations as expected from integration time (up to 10-30 seconds and 60-250 kHz frequency band)
- Noise level on cross correlations decreases as expected when increasing averaging time up to

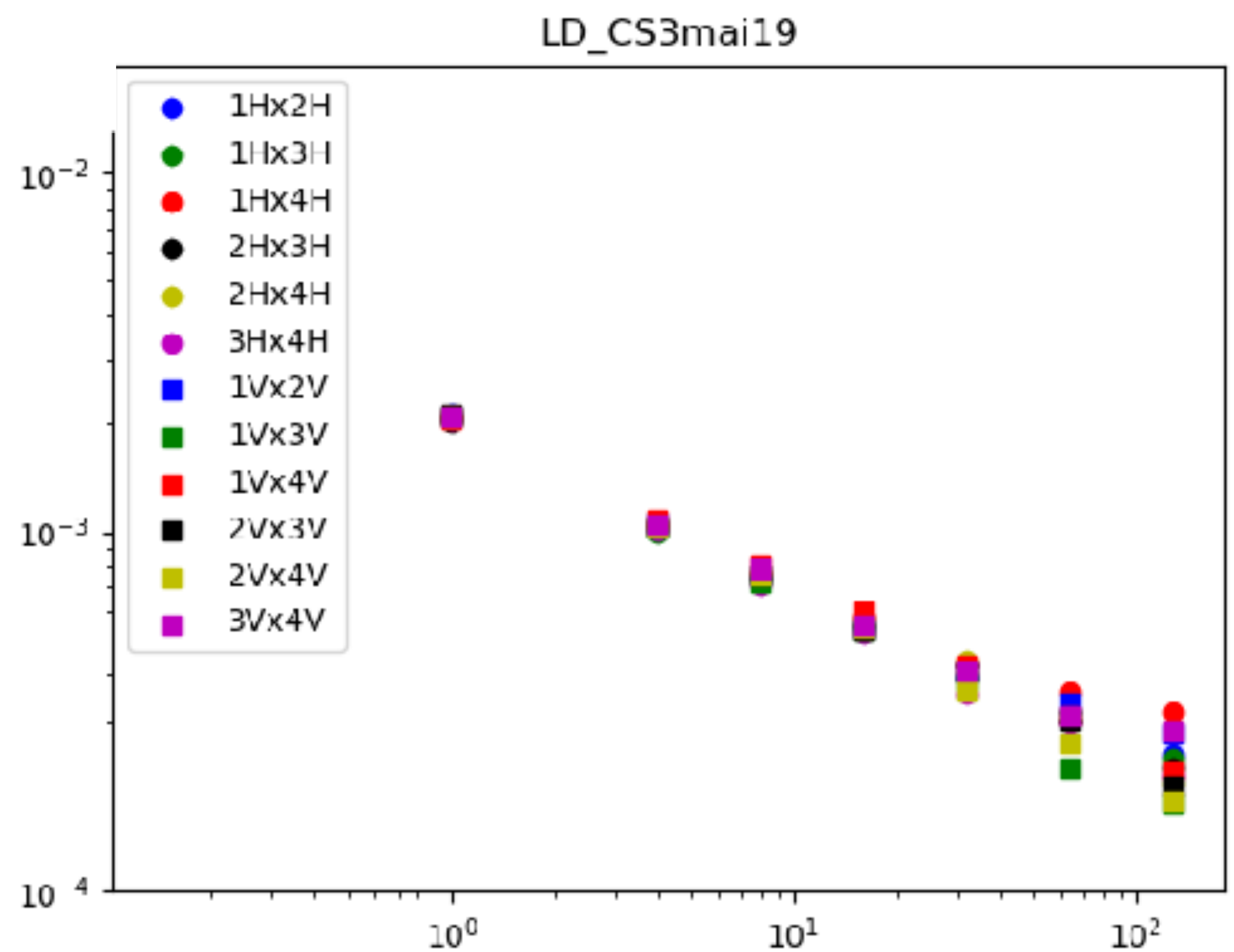


Correlated noise on 1Hx3H CrossCor - Data October 2018

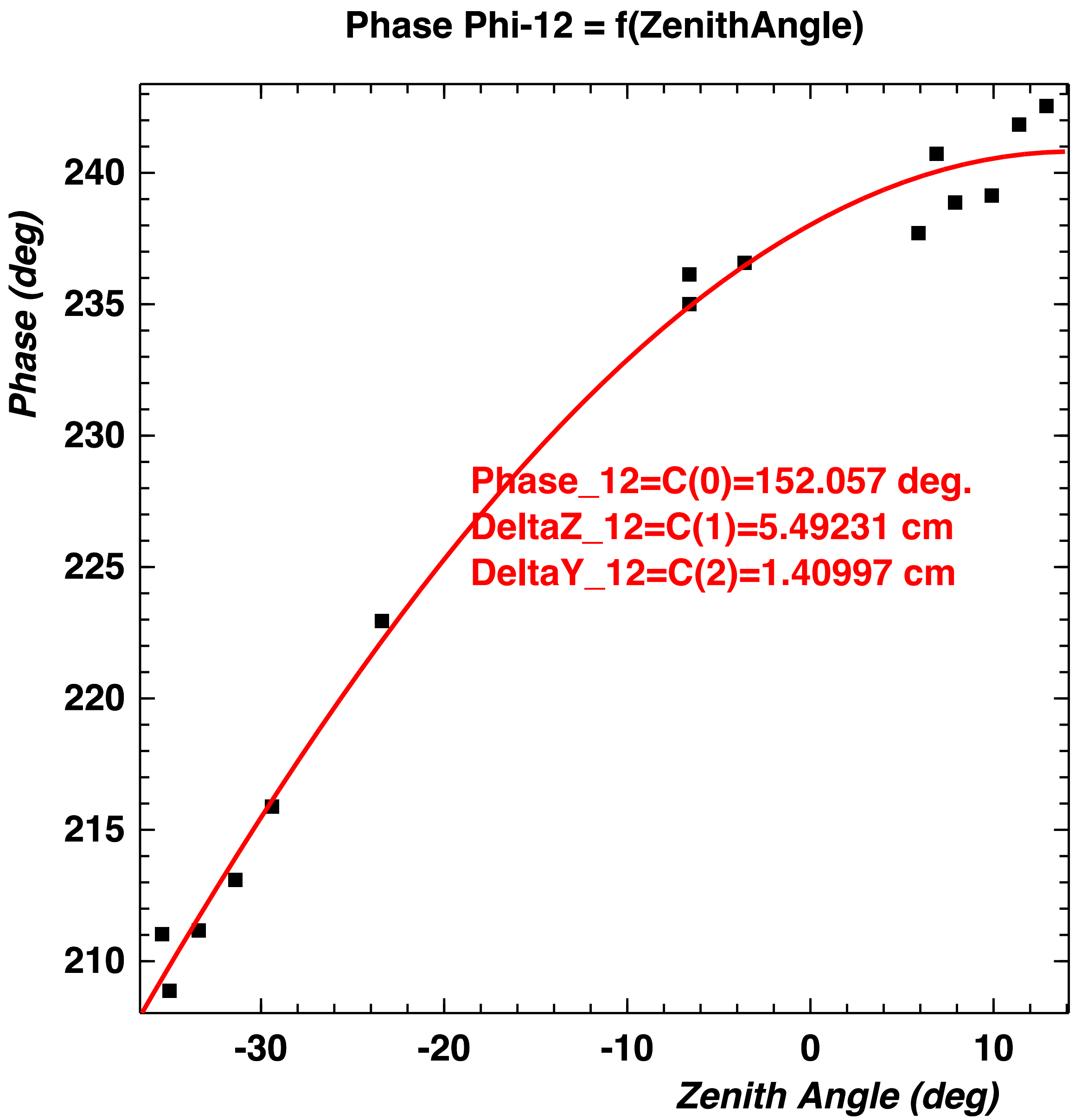


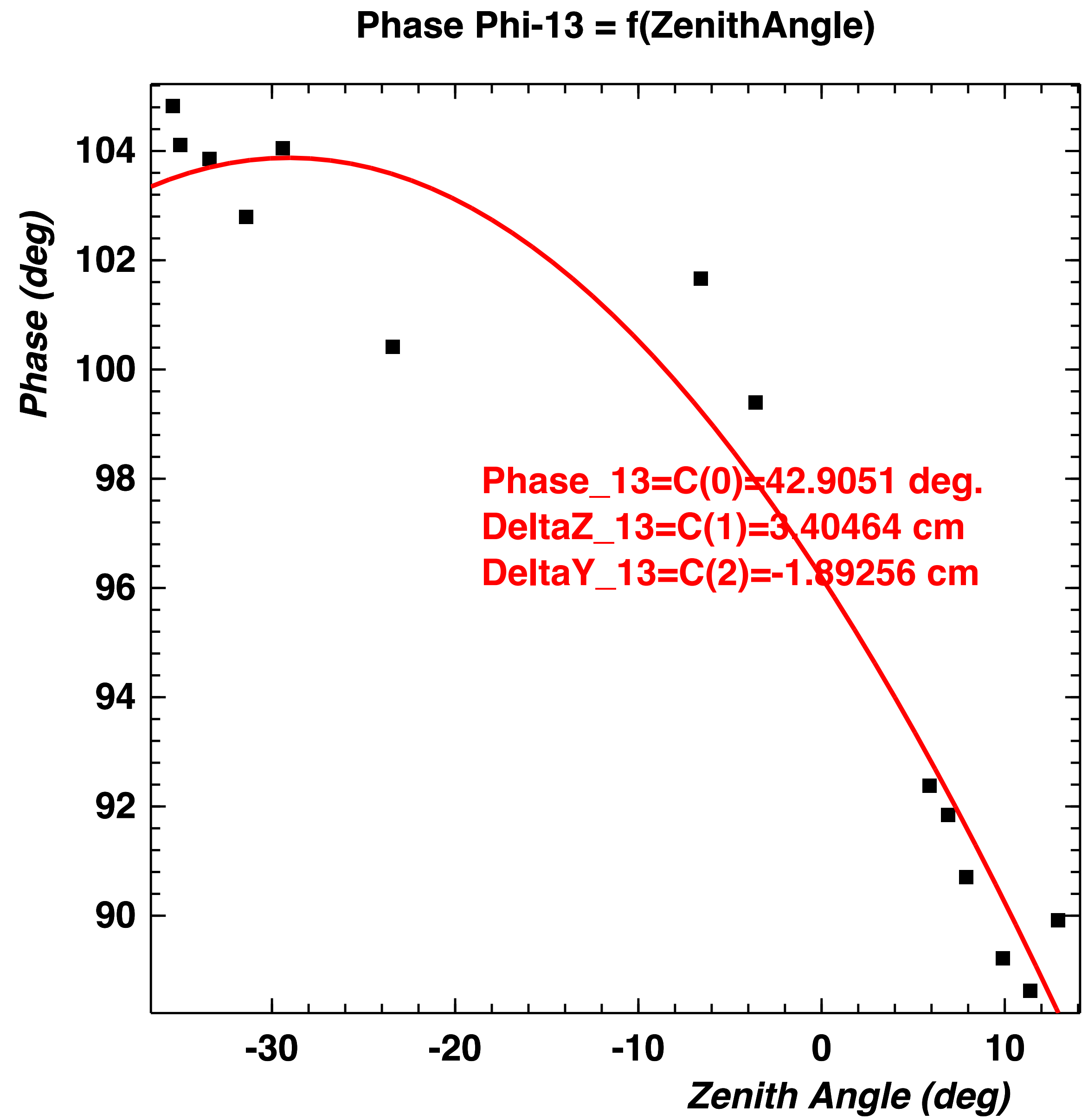
Stable, after subtraction of a single frequency dependent template



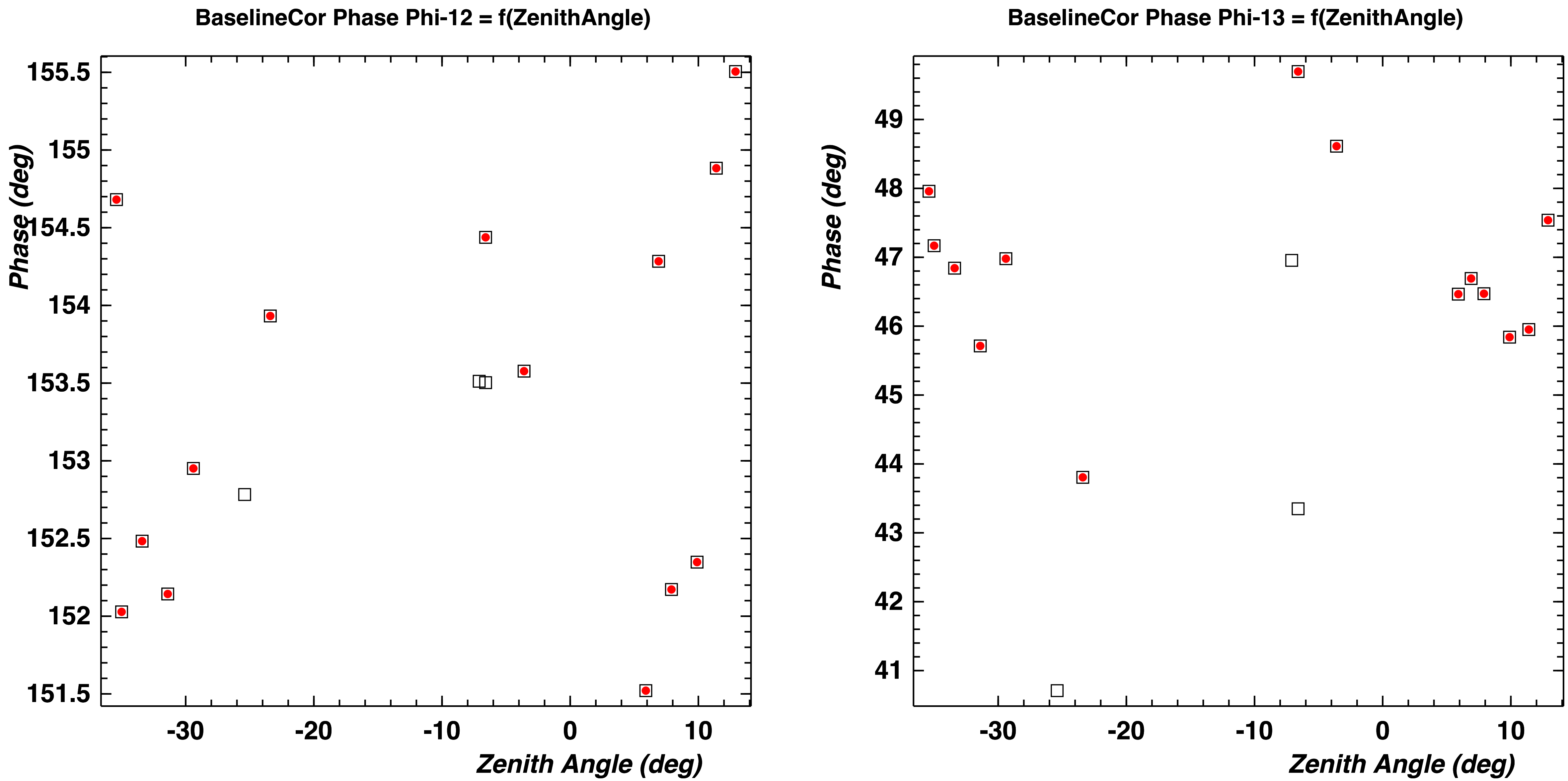


Evolution of noise level on cross correlations, with integration time (Data April / May 2019)





Phase variations (Δϕ @1300 MHz) - as a function of Zenith angle (δ ≃ 47+z)
Result from fit to Galileo satellite fringes,
PAON4 data from Oct/Nov/Dec 2018, Jan 2019, May 2019



Adjusted positions in Z (vertical) and Y (NS) -
from ~4 mm up to ~60 mm corrections on antenna 2,3,4 positions
Phase variations (Δϕ @1300 MHz) - as a function of Zenith angle (δ ≃ 47+z)
after position corrections - Δϕ @1300 MHz stable within 5 degrees
on data taken over ~ 8 months (Oct/Nov/Dec 2018, Jan 2019, May 2019)