Cancellation of GLONASS Precision Code from Cross Correlations

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Introduction

This poster describes a method of cancelling the GLONASS precision code from correlation data. The work is an extension to that described in the companion paper on coarse acquisition code cancellation.

Method

Parametric modelling of the Glonass Coarse Acquisition (C/A) code provides a method of tracking the satellite in phase and delay (See paper on cancellation of C/A code). If this is done on any pair of antennas the zero-IF signal at the two antennas can be considered to be fringe stopped. The code delay gives the correct delay for the satellite signal. This processing is shown in the upper half of the diagram below.

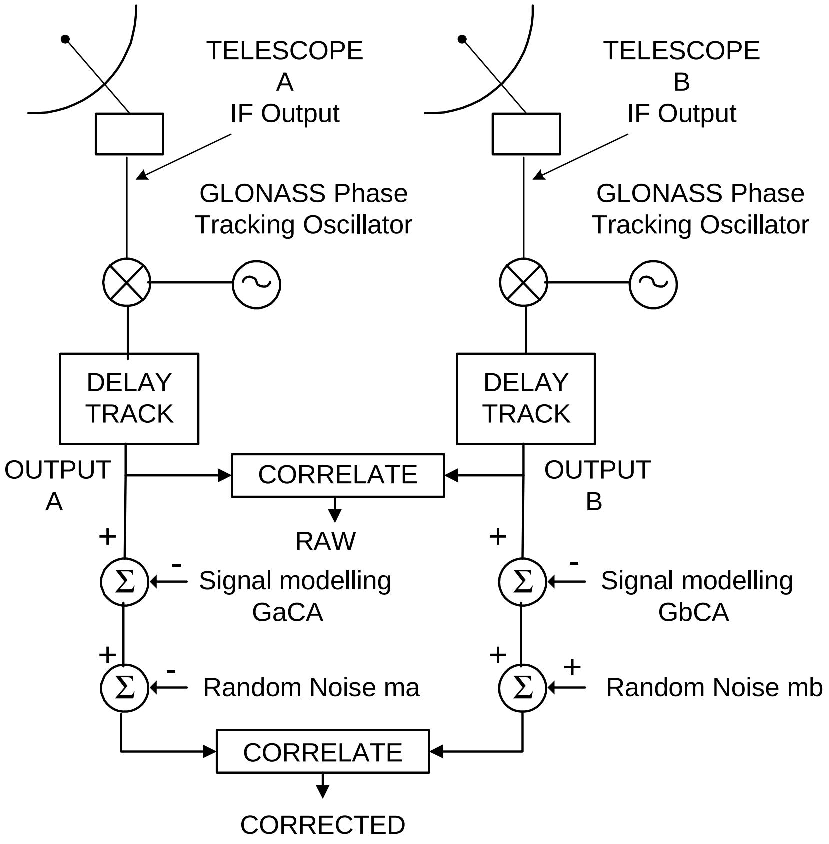

Figure 1: Diagram showing principles used in cancelling GLONASS interference from the cross correlation of two antennas.

GLONASS can be considered as a point source so the correlation between the two delay and phase tracked signals should include a component that is equal to the power spectrum of the GLONASS signal. The spectrum of the output from telescope A can be modelled as

Spectrum of OUTPUT A = Ga(CA + P + A.Ha) + Na
where
CA = GLONASS coarse acquisitions code (known signal)
P = GLONASS precision code (known spectrum)
Na = antenna noise telescope A,
A.Ha = astronomy signal and phase/delay offsets (Ha)
Ga = the antenna gain function of telescope A

The spectrum for output B is similar with Ga, Ha and Na replaced by Ga, Ha and Na. The cross correlation of the two gives

Spectrum of RAW Correlation

$$= Ga.Gb^*(CA.CA^* + P.P^* + A.A^*.Ha.Hb^*)$$

CA is known and GaCA and GbCA have been modelled (see companion paper) and also the relationship between CACA* and PP* is stable and measurable. There is enough information to generate two noise signals ma, mb with spectra Ma and Mb such that

$$MaMb = Ga.Gb^*.\ P.P^*$$

The previously modelled signals of GaCA and GbCA are subtracted from the signal to remove the CA code. The contribution of the military code is nulled by subtracting ma from A and adding mb to B. This allows a CORRECTED cross correlation to be calculated

Spectrum of CORRECTED Correlation

$$\begin{aligned}&= Ga.Gb^*((CA-CA).(CA-CA)^*) + \\ &\qquad Ga.Gb^*\ P.P^* + (-Ma).Mb + \\ &\qquad Ga.Gb^*(\ A.A^*.Ha.Hb^*)\end{aligned}$$

$$\approx GaGb^*.AA^*.HaHb^*$$

The model of CA removes the C/A code from the signal and the added random noise removes the P code from the correlation. To achieve this effect in the TELESCOPE IF simply realign the phase and delay tracking back to that of the astronomical source before subtraction or addition.

Results

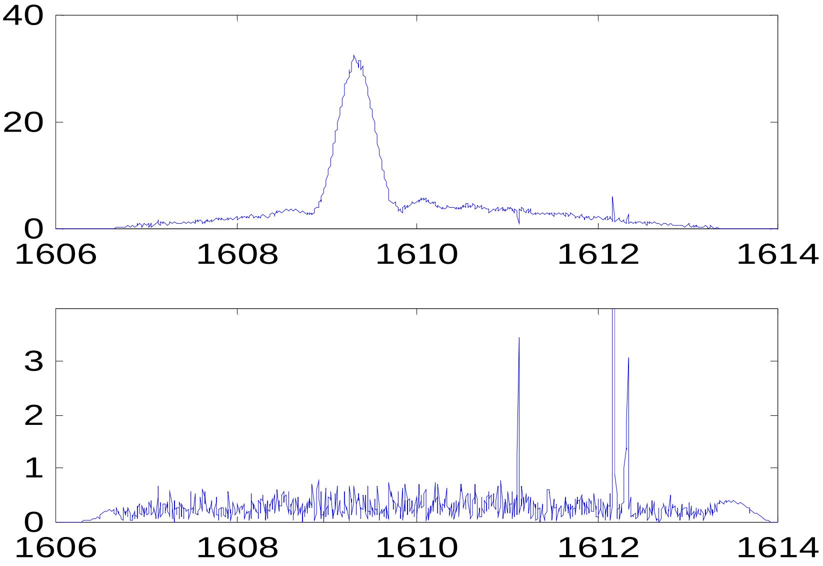

Figure 2: Upper plot: RAW Cross correlation between Australia Telescope antenna 1 and 2 showing in upper plot Glonass C/A code at 1609MHz and Glonass P code seen as broad pedestal across the band. There are two OH lines just above 1612 MHz and an artificial test signal at 1611 MHz.
Lower plot: CORRECTED cross correlation. Note change in scale. Glonass components are no longer seen in the correlation.

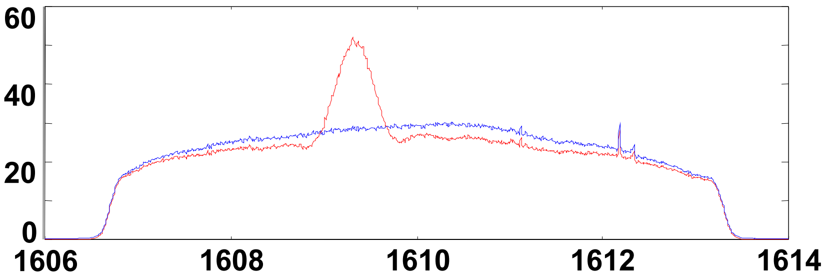

Figure 3: Power spectrum of antenna 1 before and after correction, showing removal of 1609 MHz Glonass C/A component and general increase in noise at other frequencies caused by the noise added to model the P code component.