ΔDOR data processing and analysis in CE-3 Mission

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May 2015

宇航动力学国家重点实验室
State Key Labortory of Astronautic Dynamics

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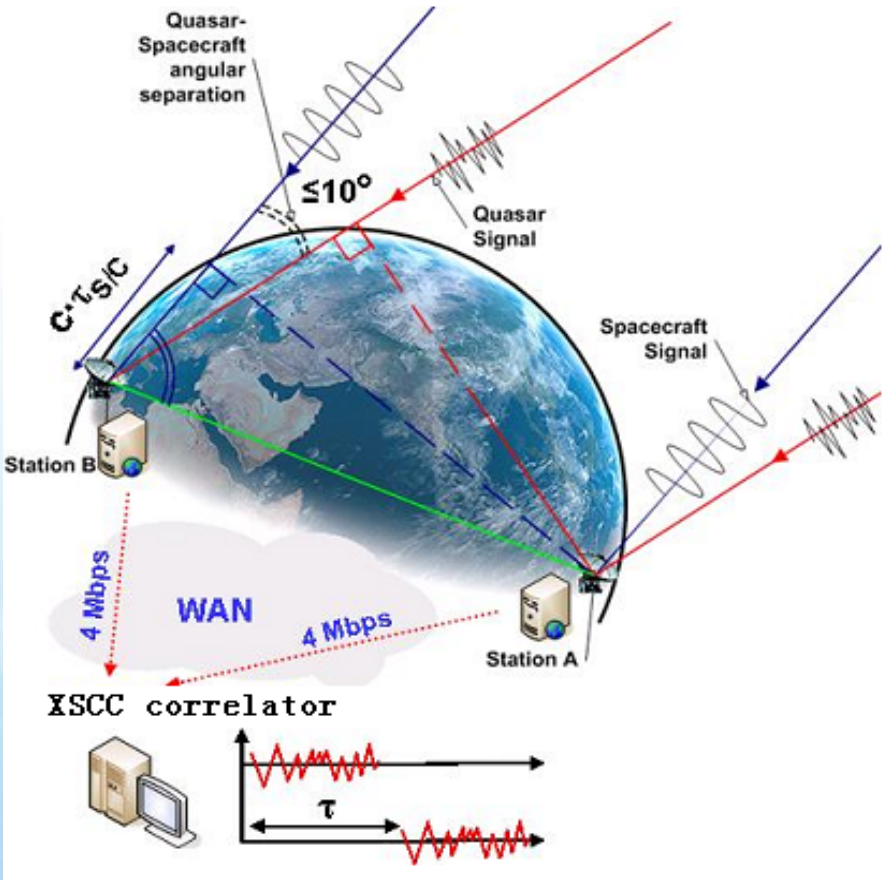
- ΔDOR data processing method
- Data processing and analysis
- Conclusion

Introduction

Delta differential one way range（ΔDOR）is a more higher precision measurement technology base on very long baseline interferometry(VLBI), which is widely used in deep space navigation. The ΔDOR principle and method of data processing are presented, and the result of the interference measurement data processing of CE-3 shows in this paper. The delay residual and delay rate residual were received by correlation algorithm and bandwidth synthesis, and the accuracy of results which is under different integral time were compared and analysis. Measured data processing results show that the delay accuracy of ΔDOR less than 1ns, which is better than the broadband telemetry signal. This study laid out supporting technique for the following high precision deep space explorations.

Introduction

ΔDOR stands for Delta Differential One Way Ranging, that is a difference VLBI technique improved from NASA of America. DOR is the measure of the difference in signal arrival time between two stations. Delta is respect to a simple DOR, and refers to quasar calibration of the DOR. Since the quasar signal is recorded on the same band width of the X channels, ideally any errors which are station or path dependent will cancel. Thus, one is able to evaluate a potentially error-free relative station delay, which leads to an accurate determination of the X position in the plane of the sky.



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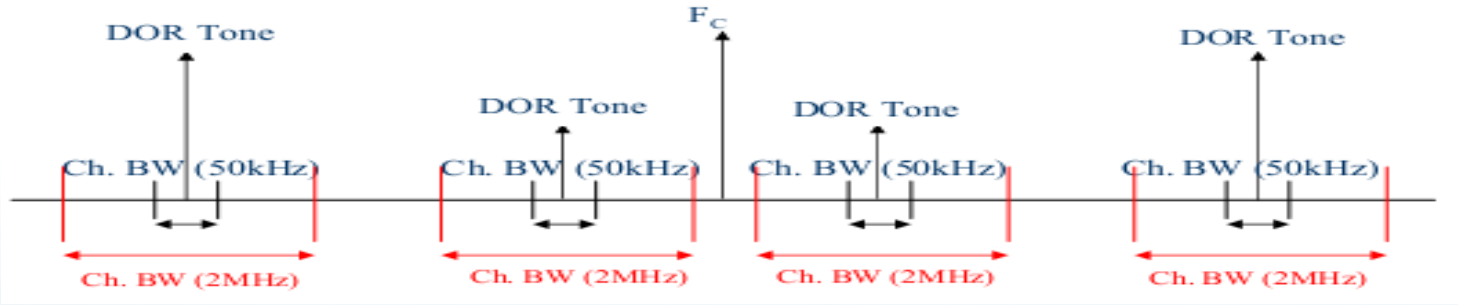
ΔDOR data processing method

1、DOR signal



2、Correlation algorithm

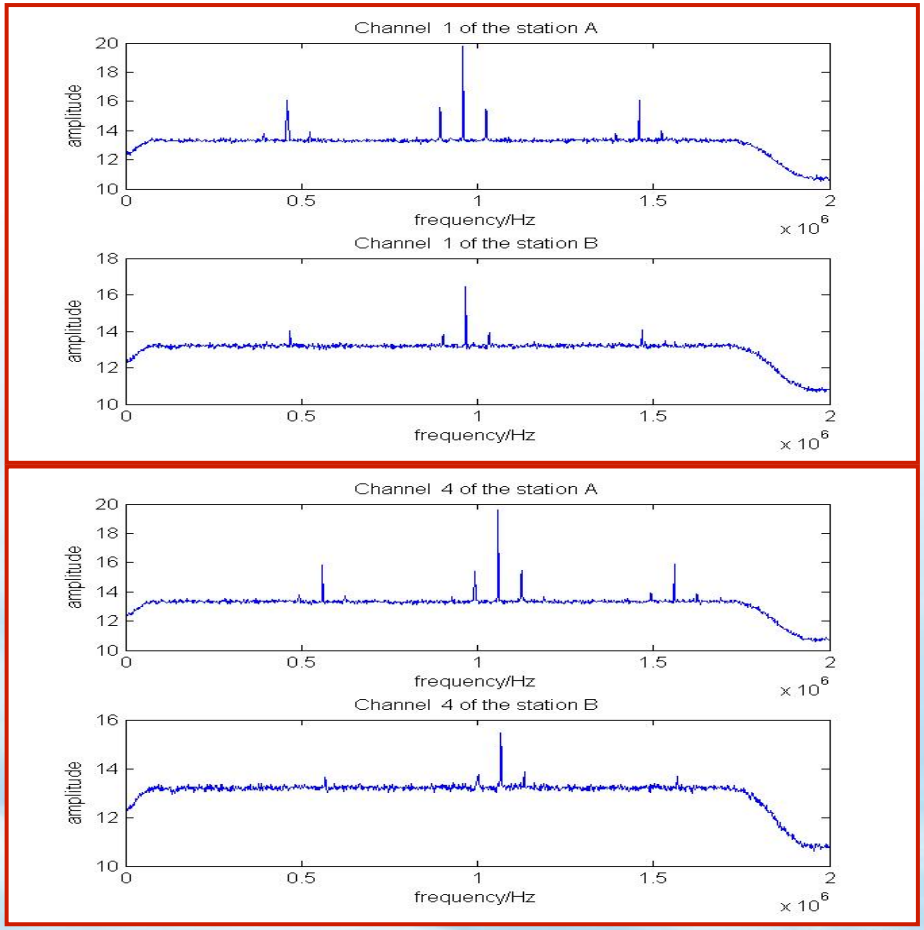
$$\tau_{SC} = \frac{\phi_B - \phi_A}{\omega_B - \omega_A}$$

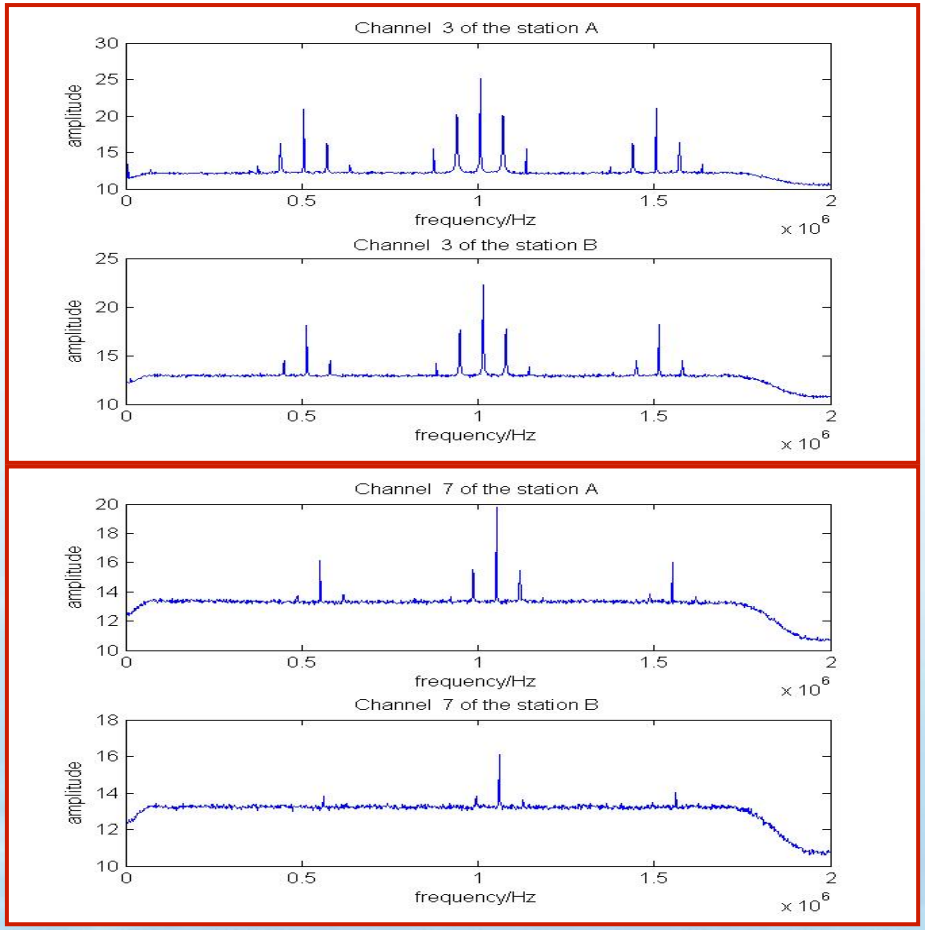
3、Bandwidth synthesis

$$\Delta\tau = \Delta\varphi / 2\pi \cdot \left(f_{\max} - f_{\min} \right)$$

Data processing and analysis

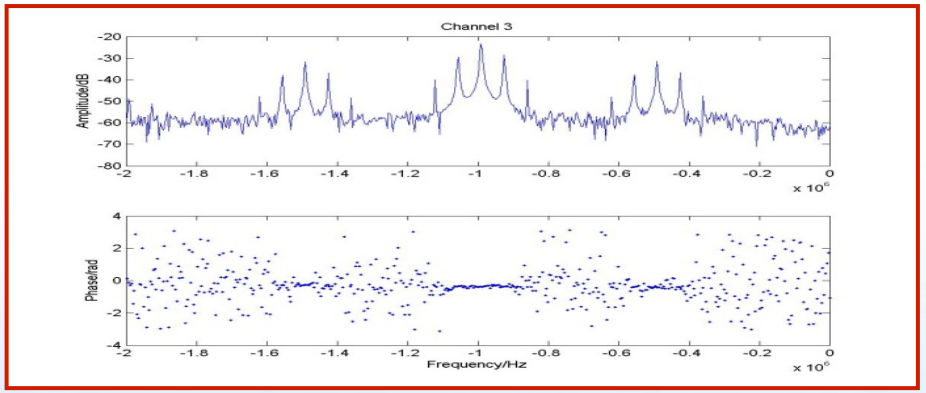
Spectrum of DOR tone signal in 4 channels

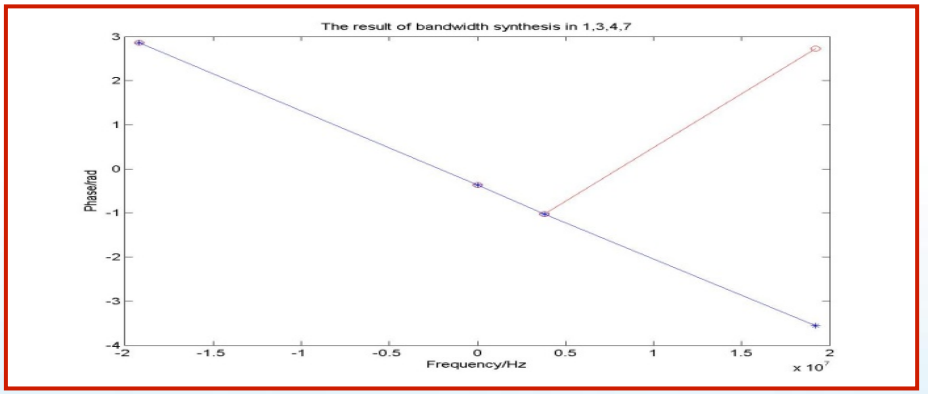




Data processing and analysis

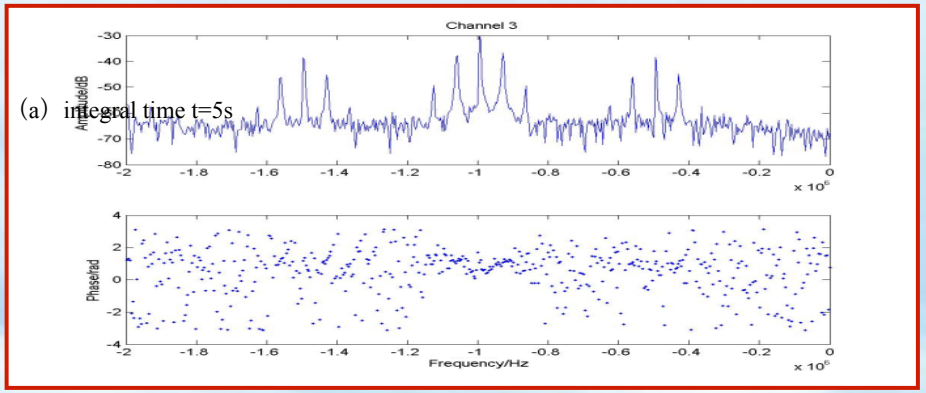
The cross-power spectrum with the different integral time

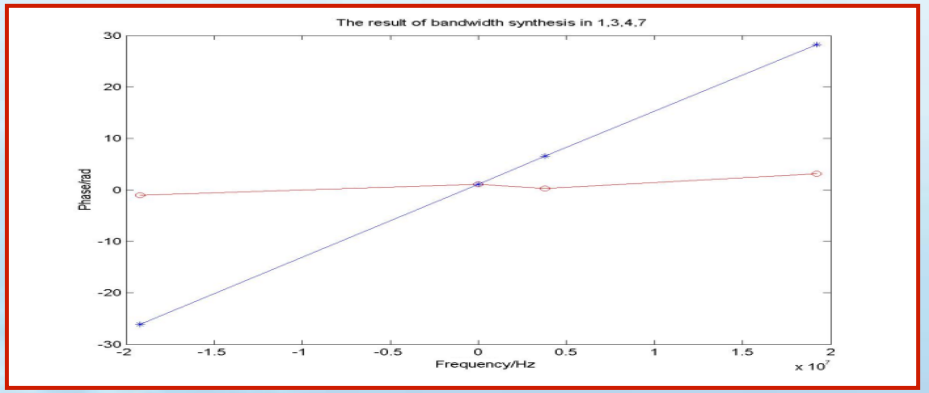




integral time t=5 s

(a) integral time t=5s





integral time t=60s

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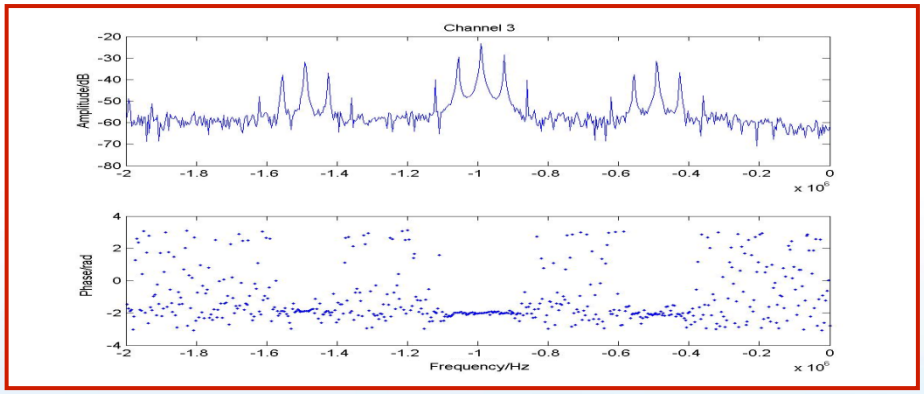
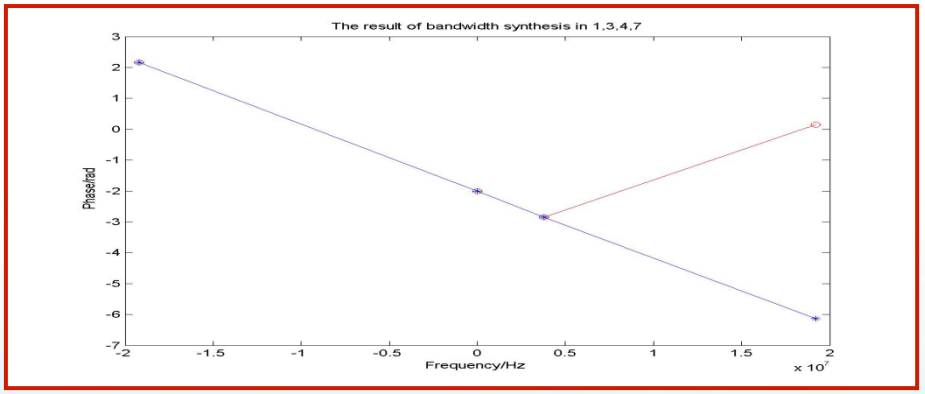
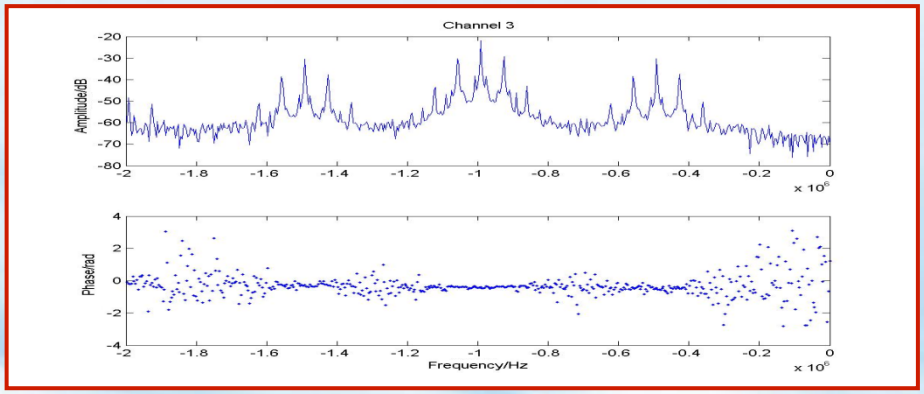
Data processing and analysis

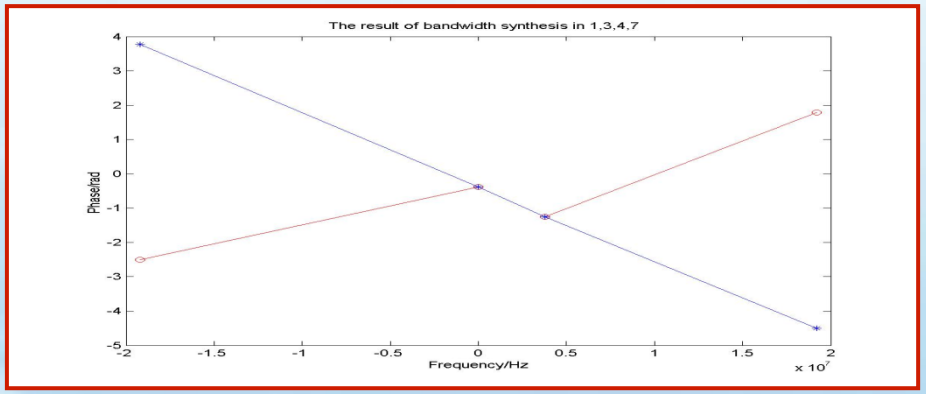
The cross-power spectrum with the different integral time after be modified





integral time t=5s





integral time t=60s

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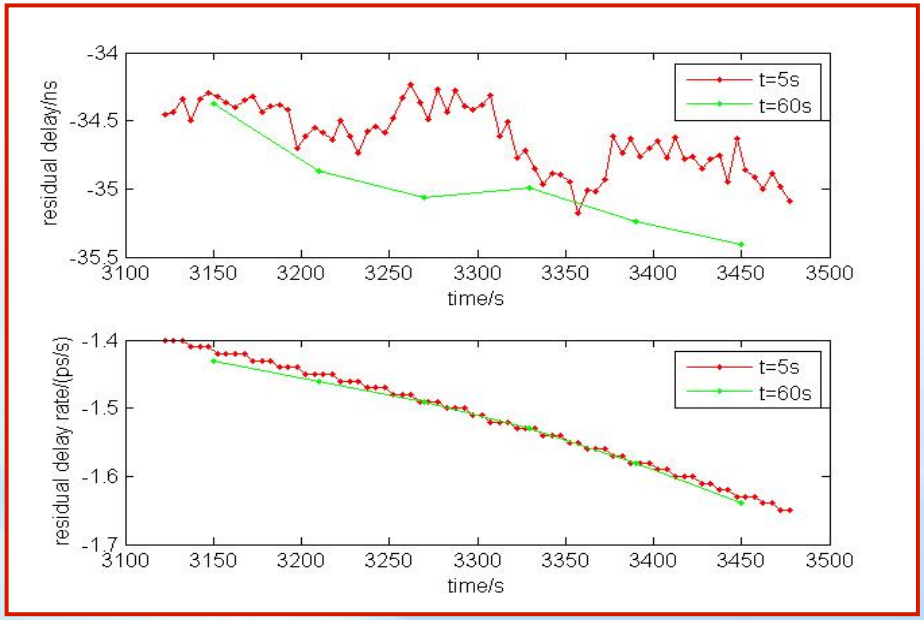
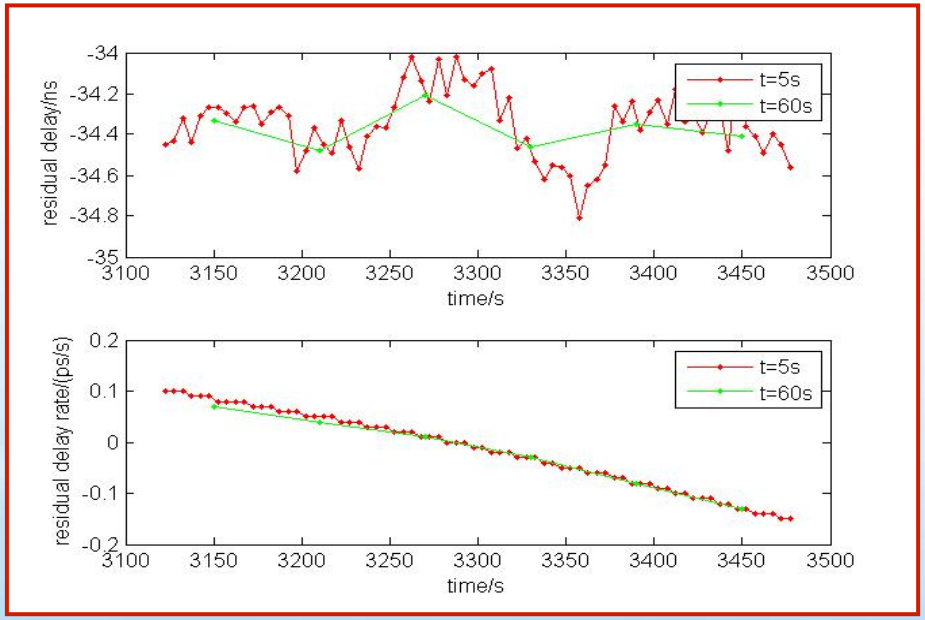
Data processing and analysis

The result of residual delay and residual delay rate



use the initial model



use the modified model

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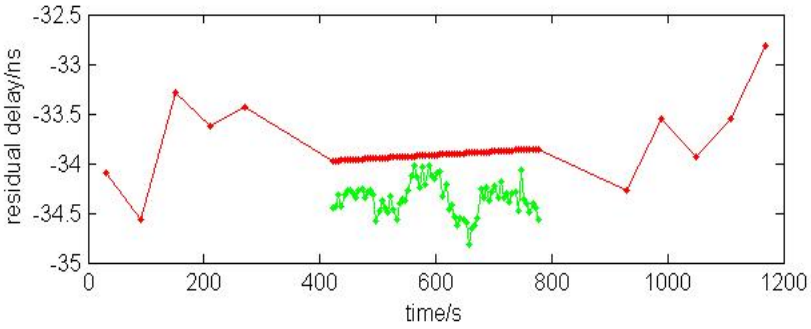
Conclusion

The ΔDOR measuring principle and data processing method are introduced in this paper, and then the ΔDOR data recorded from CE-3 mission is processed by traditional tradition correlation algorithm. We can modify the initial model to solve this problem to improve the delay accuracy. Meanwhile, the bandwidth synthesis technology is used to correct the phase ambiguity, and then we can obtain the accurate residual delay and residual delay rate. Finally, the ΔDOR is processed by using the nearby quasar, and the delay accuracy less than 1ns.



The result of ΔDOR delay accuracy


Thank you very much
for your attention!