# Baseline Measurement for Chinese Spectral Radioheliograph

***Donghao Liu1, Yihua Yan1, Wei Wang1***

1Key Laboratory of Solar Activity, National Astronomical Observatories,
Chinese Academy of Sciences,
A20 Datun Road, Chaoyang District, Beijing, China, 10012
dhliu@nao.cas.cn, wwang@nao.cas.cn, yyh@nao.cas.cn

## Abstract

The Chinese Spectral Radioheliograph (CSRH) is a solar-dedicated synthesis aperture telescope. The maximum baseline length determines the high resolution of synthetic aperture. With its antenna array aligned in a shape of triple-spiral arms spread in an area of about 10 square kilometers. The measurement precision of CSRH tri-spiral antenna array baseline is one of the key factors for CSRH image quality. In this paper, the method of geodetic surveying and astronomical interferometry used to obtain the 3D coordinates of different antennas is introduced. The results will be verified by observing the radio source [1-3].

## 1. Introduction

Radioheliograph obtain the sun image in radio band based on the synthesis imaging principle. The accuracy of delay and phase compensation will affect the related results. And geodetic delay is calculated from the baseline vector. So the high precision antennas position measurement is one of the key factors for recovering the sun image with high fidelity of intense and location [4].

We use the geodetic coordinates measured way to get the initial position of the antenna. Then through the observation of astronomical sources we calculate geodetic delay to obtain biases of the position coordinates using least-squares fitting. Finally, by the positional biases we corrected antenna precise location.

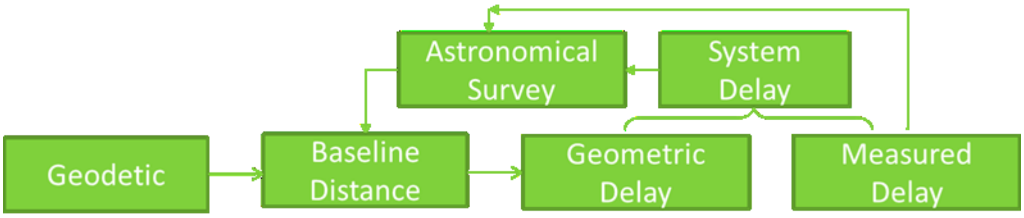


Fig.1, Flow chart of baseline measurement

## 2. Description of the triangular network settings and measurement

Construct the geodetic monitoring network. This control network used the Polaris to determine the direction and the coordinate system which is the left-hand system. There are 33 measure-control points in this network and they followed the principle of equilateral network and distributed in a 10 square kilometers area. Level Angle all round observation method was adopted in the total station and measured the whole net adjustment determining control point coordinates. The antenna machining precision and installation accuracy guarantee the relative position between the center of antenna and its foundation bolts. Therefore, antenna benchmark survey points were set in the center of the four foundation bolts. And the total station frequencies ranging is up to 50MHz~100MHz. After adjustment, we determine the 3D position of the antenna. The measurement accuracy RMS is 5mm [5].

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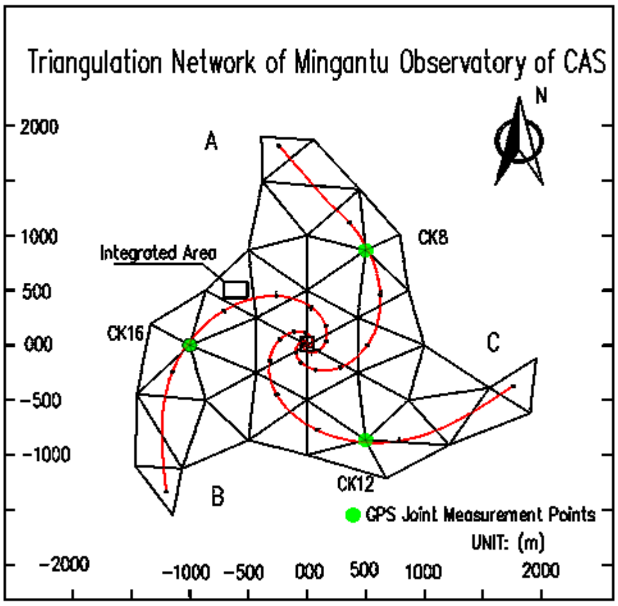


Fig.2, system block diagram of CSRH-I

## 3. Astronomical interferometry measurement results

Combining with optical measurements we plan to observe to the sun, satellite and some intensive radio sources. We use cross-correlation delay estimation algorithm to get the delay of the antenna baselines and use least square method to get the length of the baselines [6]. The measurement of astronomical interferometry baseline is between the antenna feed of the phase center, so it can make up for the geodetic measured insufficient. The phase generated for position deviation is changes over the time. We build fitting of the Jacobian matrix and portfolio analysis to deviation in different ways for the entire phase residual effects [7]. Then we will give the contribution of position deviations on phase residual. And finally according to the deviation of the observational data we determine position deviation to approximate the actual observation of the data. We observed the sun as a calibration source. The result was that we calculated the phase though integration time of 30ms and bandwidth of 25MHz [8-9].

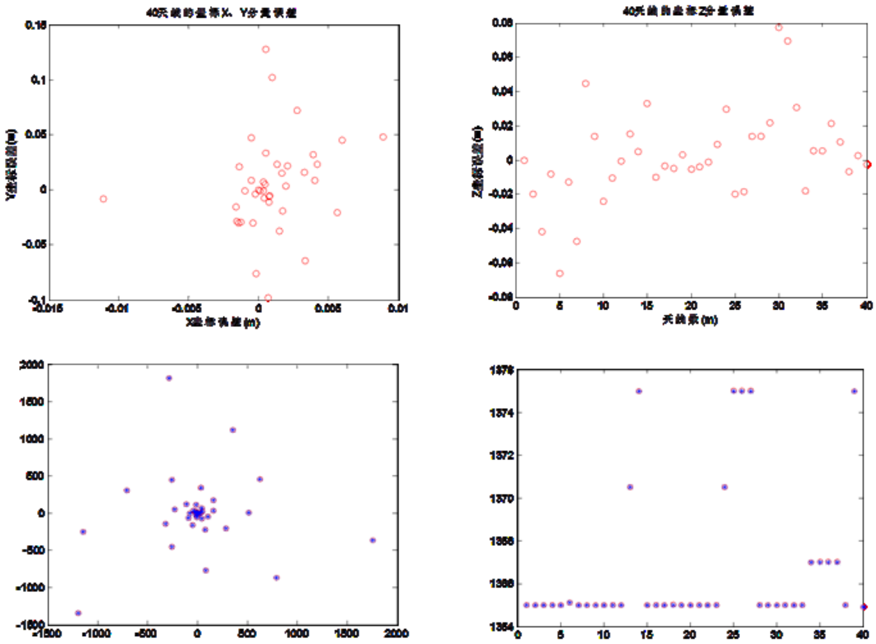

Fig.3, Measurement result for CSRH-I

## 4. Analysis of observation error

Through fitting phase and delay we obtained phase center of antenna feed. Short baseline deviations are smaller and larger baseline deviations increase. Range errors are in the cm range fluctuations. Its causes are as follows:
A) We observed solar sources for calibration sources, and the solar activity cause phase fluctuations. Long baseline get low signal-to-noise ratio, so the result is volatile phase;
B) Satellite location theory and prediction of the position of the source of the deviation is large. Where the calibration source of the deviation is large, so it will affect the results of fitting;

Next we will add an analog back-end 20dB amplifier for astronomical observation of the weak source and reduce the impact of source's theoretical position deviation. Thus we will expect to get a good result.

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