# 同一ビーム内の複数静止衛星のVLBI観測について（その2）
# VLBI observation of multi-geostationary satellites in a same antenna beam II

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## 1. Introduction

On a VLBI observation of multiple geostationary satellites received in the same antenna beam, it is unable to separate each satellite independently by using a conventional processing system (Fig.1). In order to get each satellite delay we have improved the correlation software and delay search software to get observed delay. Improved software was evaluated by using laboratory experiment data and true observation data as well. We could confirm that expected results were obtained.

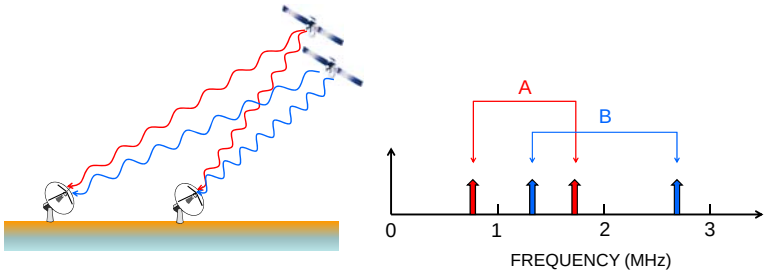


*Fig.1 Multiple geostationary satellites in a same beam and frequency allocation*

## 2. Improvement of the software

The software correlator (K5 correlation processing software) was developed for geodetic VLBI system. It is therefore assumed that white noises from a quasar are received and processed. On the other hand multiple narrow band signals are received in case of a geostationary satellite observation. In this case a so-called "delay resolution function" shows a comb-like form unlike the case of white noises. In case of receiving signals from multiple satellites the delay resolution function becomes a combination of functions for multiple satellites, and it is impossible to separate to each delay resolution function. However if frequencies differ among satellites, it becomes possible to get a delay resolution function independently by filtering at either correlation processing or delay search processing. Hence filtering function was implemented in the correlation software and the delay search software. In addition, envelope interpolation function is also implemented in the delay search software for processing a comb-like form delay resolution function.
Two kinds of filtering method are possible for correlation processing; one is filtering on the time domain and the other is on the frequency domain. We have adopted the frequency domain filtering considering from reasons such as ease of both implementation and change of filtering characteristics. It has also been adopted to the delay search software.

## 3. Evaluations

In order to evaluate the function and performance of revised software, data processing was carried out by using laboratory experiment data and true observation data. A laboratory experiment was carried out using four signal generators (SGs) and a 4-ch sampler as follows (Fig.2). Two pairs of SGs simulate two satellites and signals are mixed each other. They are then fed to two input channels of the sampler through coaxial cables with different lengths. An extra cable is applied between two pairs of SGs to simulate the path difference of satellites.

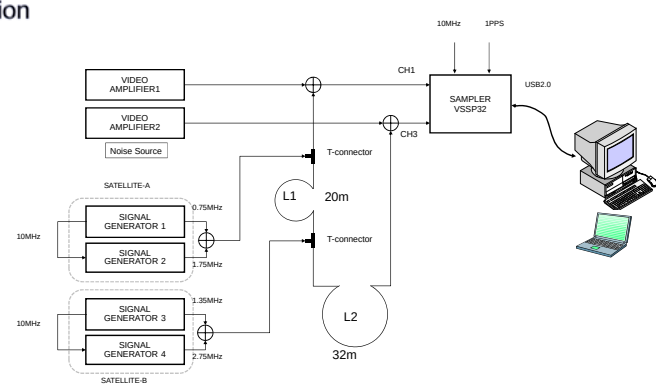


*Fig. 2 Laboratory experiment assuming two geostationary satellites*

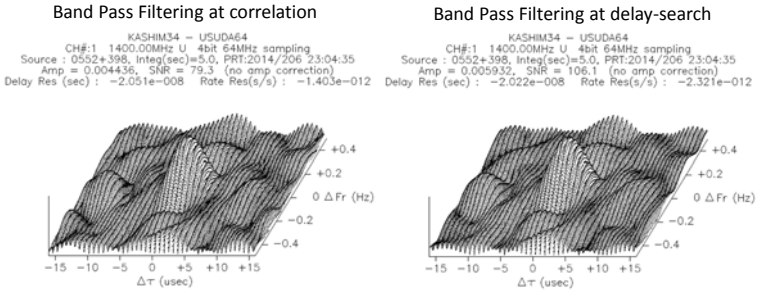


*Fig.3 Comparison of delay search function. Left: Band-pass filtering (BPF: 1.35+/− 0.1MHz and 2.75+/−0.1MHz) at correlation processing. Right: same BPF at delay search processing. The shape of search functions well coincide with each-other.*

Sampled data are processed by revised software. By using a filtering function, delays for simulated two satellites are successfully separated. Two cases of filtering, one is at correlation processing and the other is at delay search processing, are compared (Fig.3). Observed delays are well-coincided with each other. The comparison was also carried out by using true observation data, and it was confirmed that both results are well-coincided. It is also compared between the two delay search methods; one is a conventional way and the other is an envelope interpolation. Daily variation can be seen in the difference between delays obtained by two methods, and peak-to-peak variation reaches a few hundred nanoseconds. More detailed evaluation should be made through the determination of satellite orbit.

## 4. Summary

A filtering function was implemented in the correlation software and the delay search software to get delay for each geostationary satellite independently under the condition that multiple satellite signals are received simultaneously. An envelope interpolation function is also implemented in the delay search software for processing delay resolution function when it shows a comb-like form. According to evaluations by using both laboratory experiment data and true observation data, it is confirmed that improved software shows an expected performance. As for more detailed evaluation, it is necessary to carry out the determination of satellite orbit.