

Bandwidth synthesis of VLBI data observed with USB+LSB channels

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Bandwidth synthesis (BWS) is a technique to derive group delay, which is one of direct observables in a geodetic VLBI, with the precision as same as that obtained using the data observed with a wide bandwidth by combining a number of narrow bandwidth data. Only the upper sideband (USB) video signals have been recorded in geodetic VLBI observations for a long time. Recently, some geodetic VLBI sessions start to use the lower sideband (LSB) video-signal channels in addition to USB channels. Two frequency channels out of 8 frequency channels in an X-band are assigned to be observed at both sidebands in these sessions. Therefore KOMB, that is BWS software developed by NICT, was updated to process the both sideband data. Cross correlation processing is carried out for USB and LSB data independently. Thus USB and LSB correlation data should be merged before proceeding to the BWS. If the phase characteristics of an image rejection mixer (IRM) used at a video converter is ideal, it is easy to connect both sideband correlation data by merely putting positive frequency component of USB cross-spectrum to positive frequency domain of a merged spectrum and negative one of LSB cross-spectrum to negative frequency domain. However, this simple method usually does not work well due to the phase error arising at the IRM. Thus we propose two methods to connect USB and LSB correlation data: 1) connecting phase continuously at base band frequency; 2) equalizing both sideband phases averaged over each sideband. These two methods have been evaluated by comparing the quality code (QC) obtained by every method where QC is an index computed from variances of phase data after the BWS and those obtained theoretically from a signal to noise ratio. Evaluation results show that use of averaged phase (Method 2) gives a better result. Phase characteristics at the band edge of a video band is usually degraded compared with those at the band center. This will result in less QC in case of the use of phase at baseband for the connection of USB and LSB data. However, conventional processing using only USB data gives better QC than that of Method 2. This can be also explained by a band-edge effect but not at a video-band but at an IF frequency band. LSB channels used by the current evaluation are located at both band-edges of the IF band. The weighting factor of a combined USB and LSB channel in the BWS is two times as large as that of the USB channel data. Degraded phases at both band-edges could therefore influence the BWS results severer than the case of the use of USB channel only.