広帯域バンド幅合成について(その2)
On a wide-band bandwidth synthesis II

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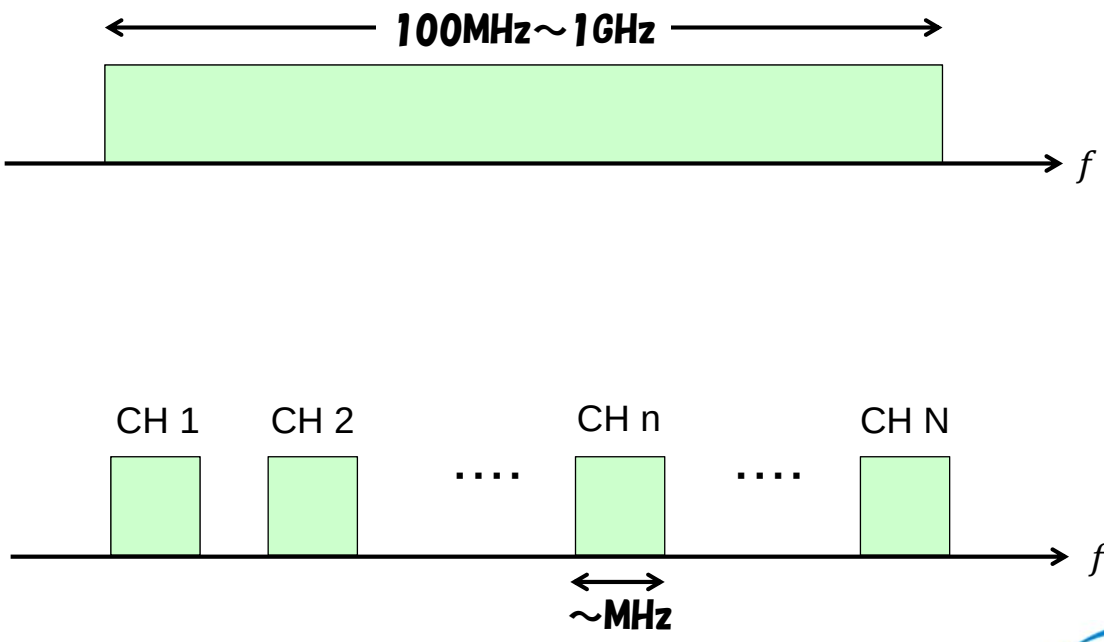
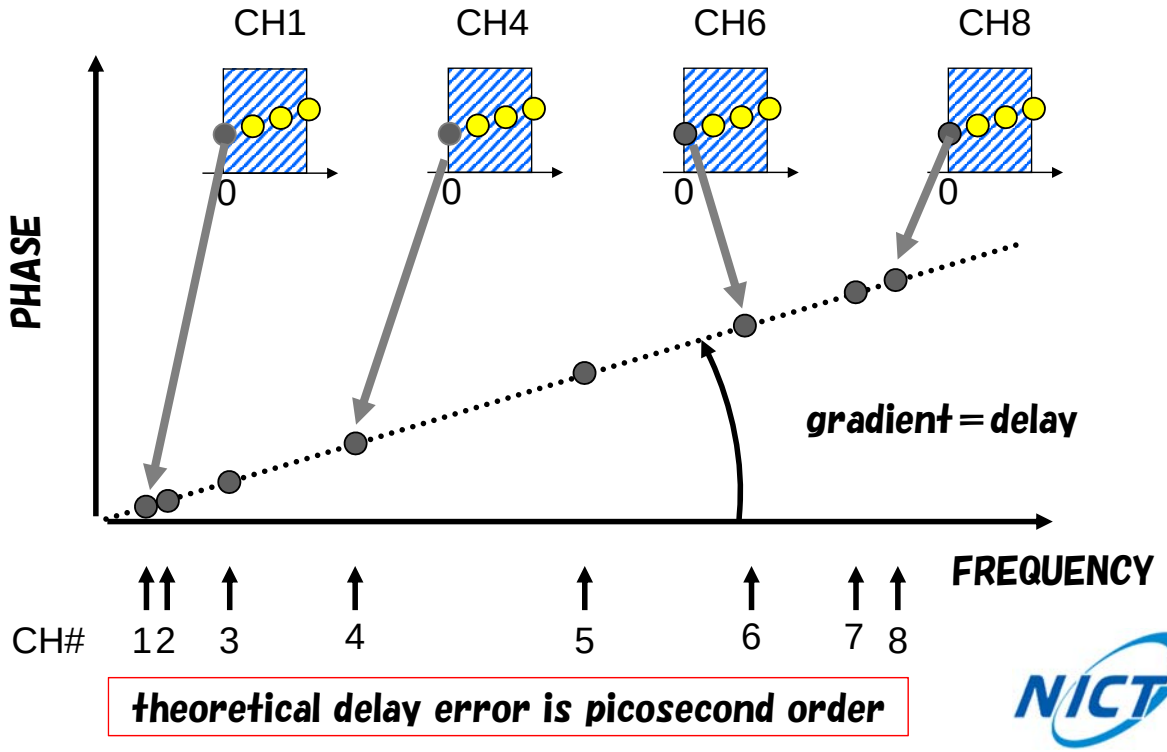
- Review of bandwidth synthesis
- Results of wide-band bandwidth synthesis on a short-baseline VLBI
- Inner-band phase correction and inter-band delay correction without the use of phase calibration (PCAL) signals
- Ionospheric correction on a long-baseline VLBI will be adopted next

Conventional Bandwidth Synthesis (BWS)

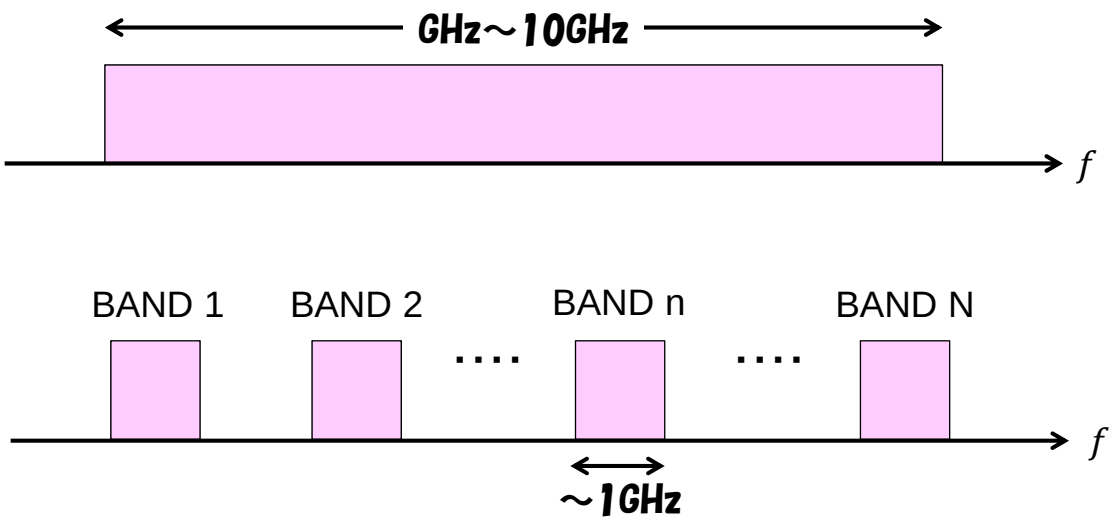


Bandwidth Synthesis



theoretical delay error is picosecond order

Wide-band Bandwidth Synthesis (WBWS)



bandwidth of conventional BWS

Connect Bands

try WBWS consisting of 6 bands using test experiment data carried out on Kashima-Ishioka baseline in January, 2015

neglect the effect of ionosphere because of short-baseline

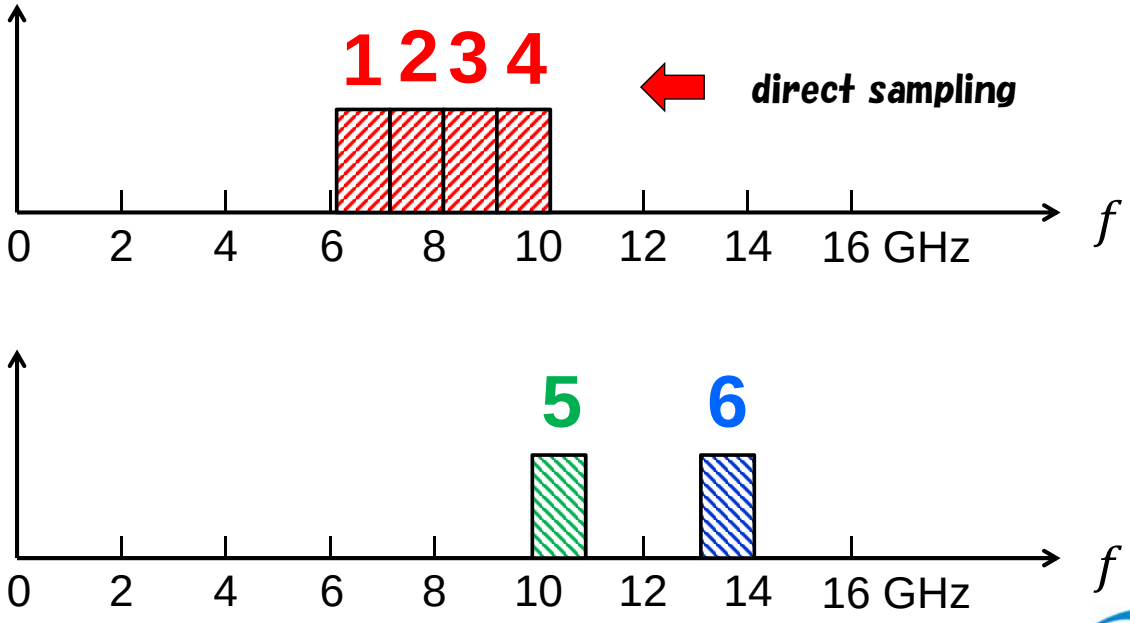
establish a WBWS technique without the use of PCAL signals

Kashima – Ishioka baseline

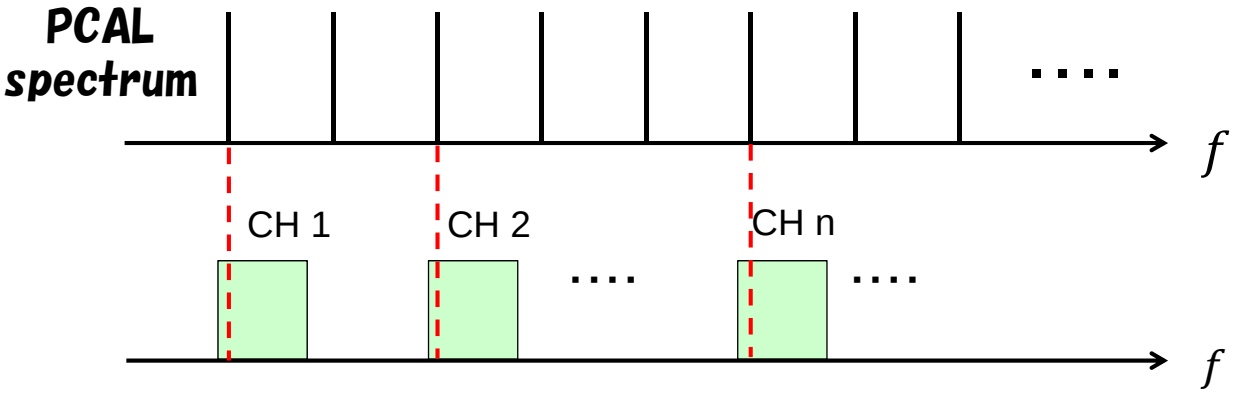
Ishioka 13m Antenna

Receiving Bands

1024MHz bandwidth/band



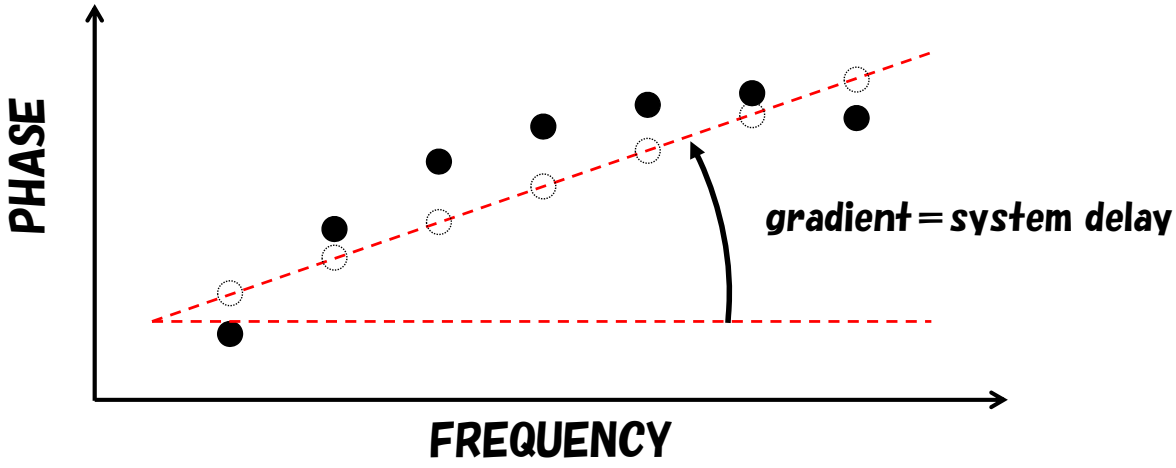
How to use PCAL signals in conventional BWS



use PCAL signals to correct phase of each channel

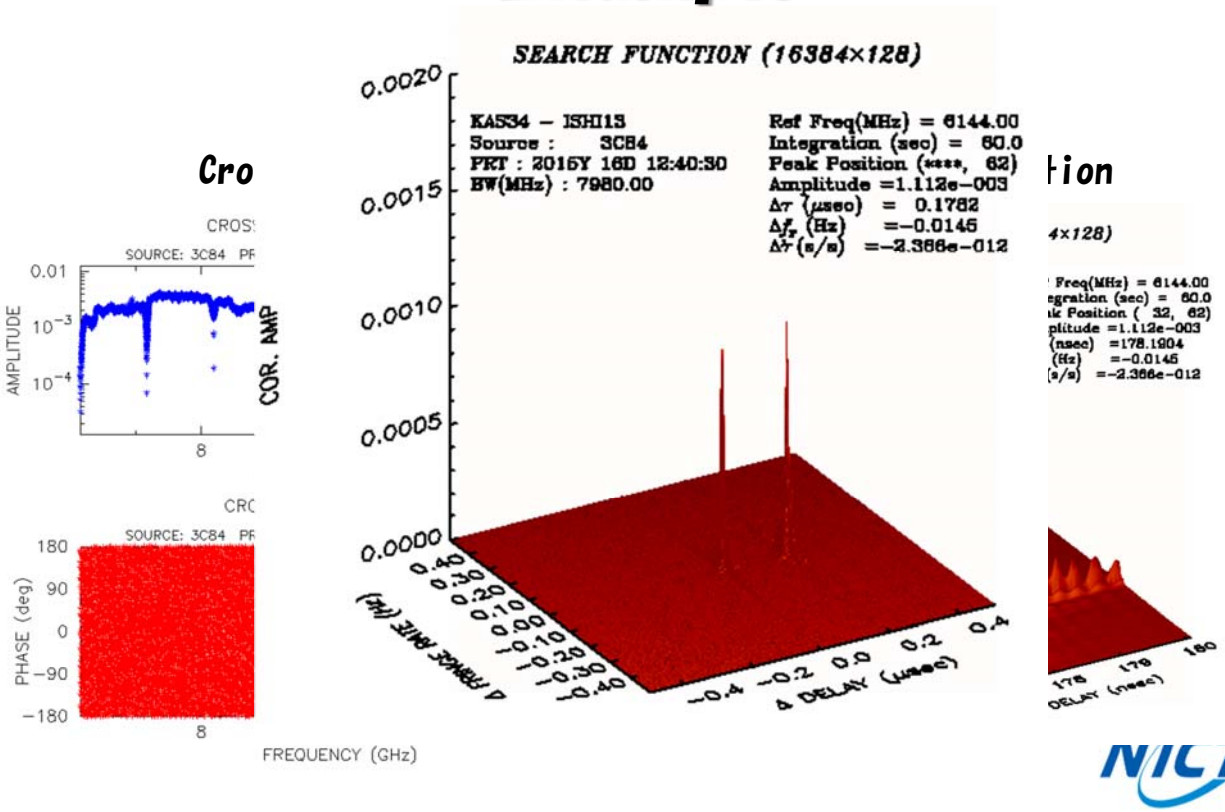
How should PCALs be used in WBWS?

in case of ideal PCAL signals



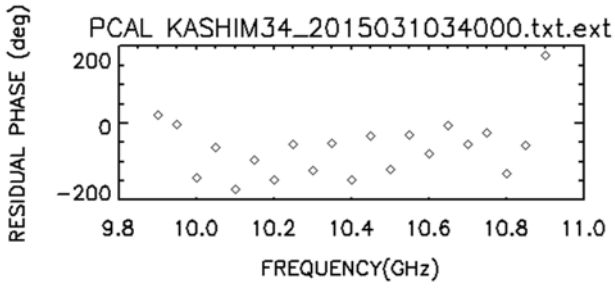
- to correct inter-band system delay
- to correct phase characteristics in a band
- to connect inter-band phase

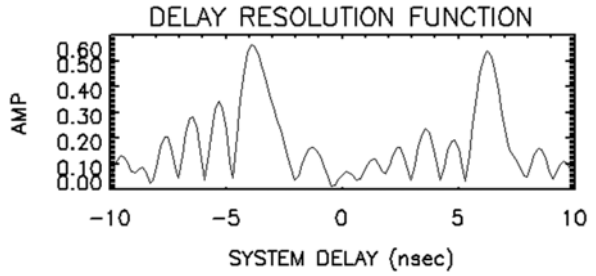
Example



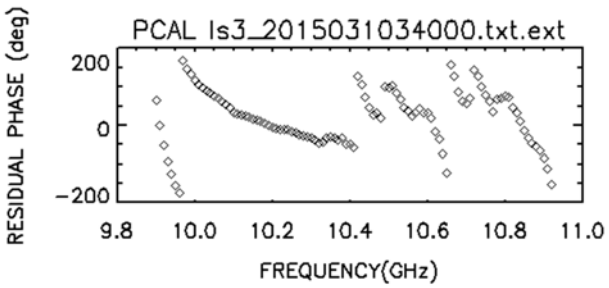
What happened on actual PCAL signals?

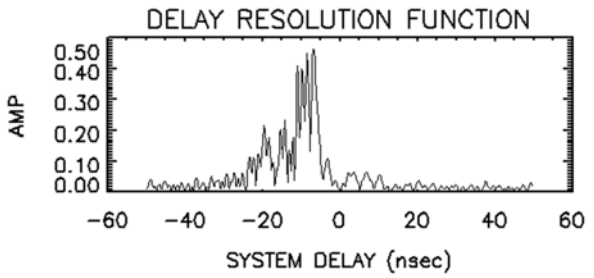
Kashima





Ishioka

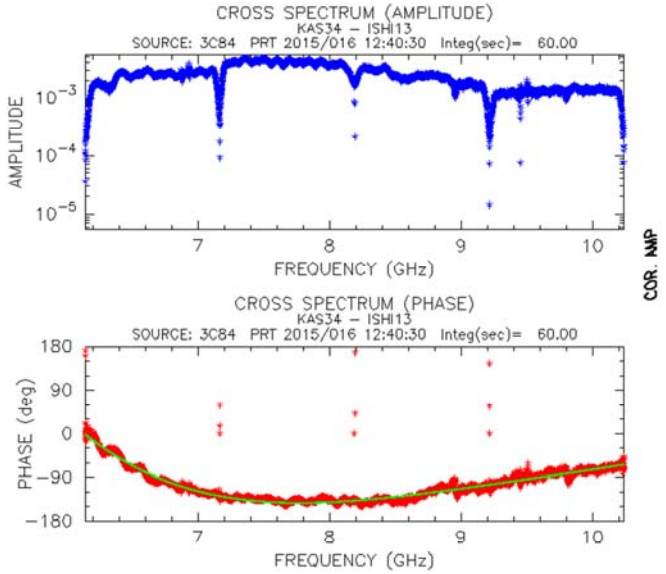


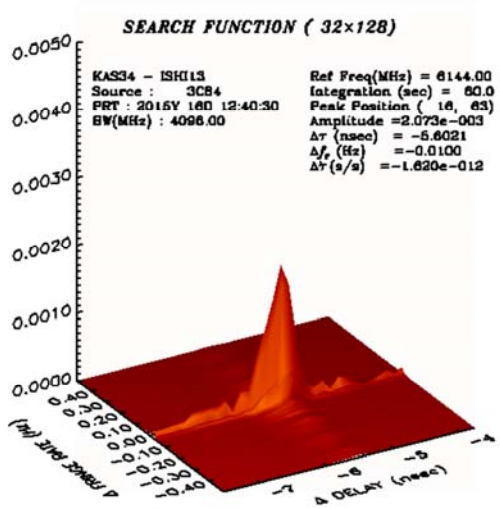


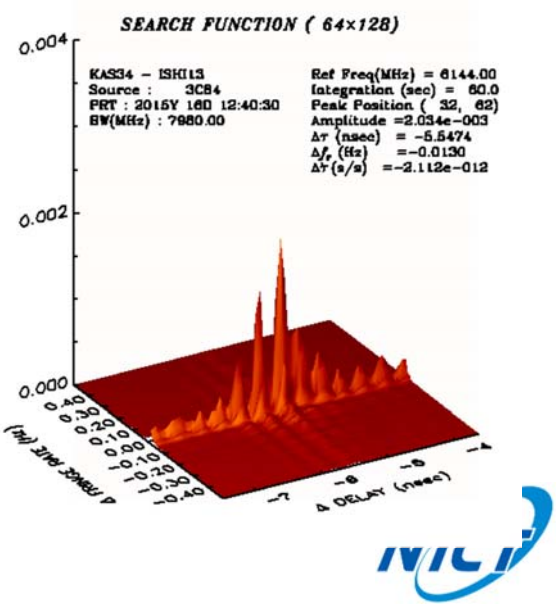
How can we get correction data without the use of PCAL signals?

- at first define a reference scan (strong enough source)
- get inter-band system delay
  - obtain residual delay by band
  - get relative delay difference against a reference band (lowest frequency band)
- get phase characteristics in a band
  - obtain cross spectrum after delay residual is removed
  - fit phase spectrum with a polynomial of the 4-th degree
- calibrate another scan data by using the correction data obtained for the reference scan

Example of single band processing (Band#1, #2, #3, #4 can be regarded as a single band because of direct sampling)



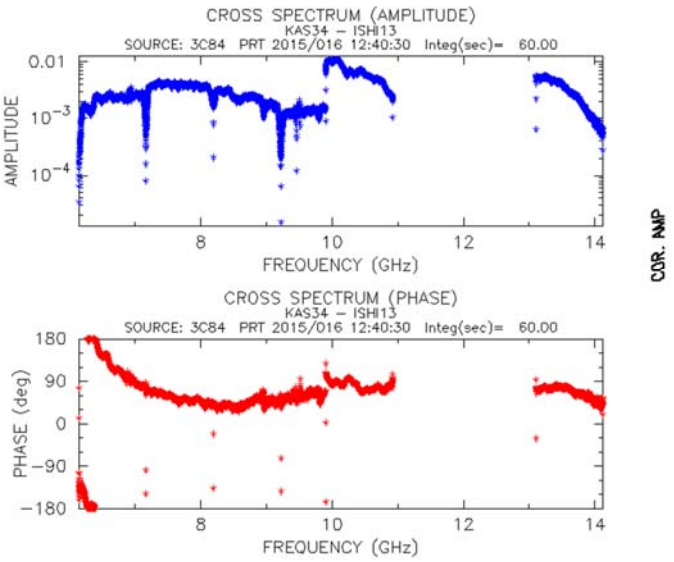




Example

WBWS after inter-band delay correction

cross spectrum

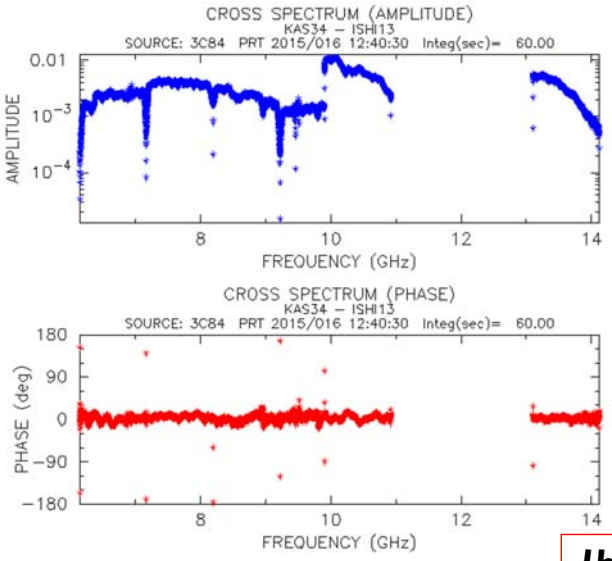


search function

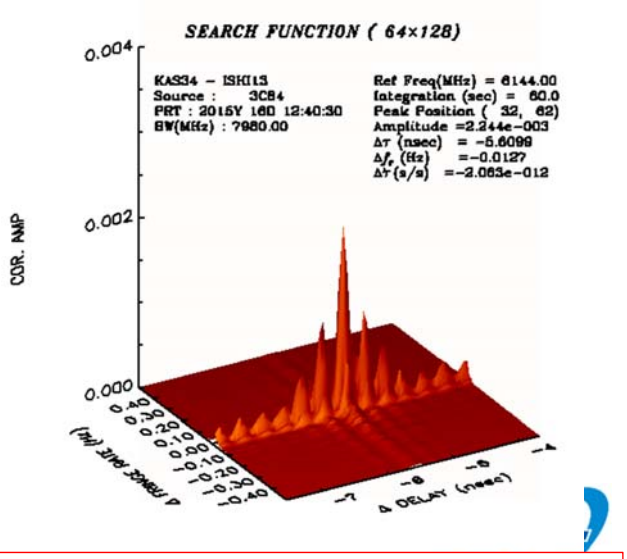
Example

WBWS after inter-band delay and phase (in a band) correction

cross spectrum

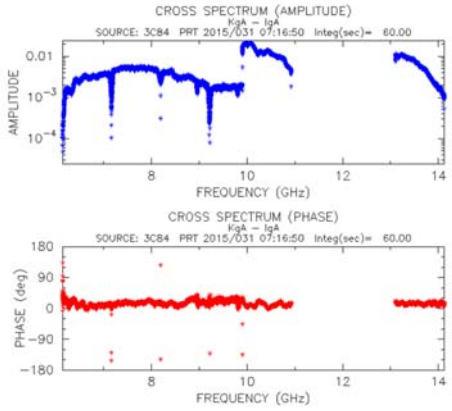


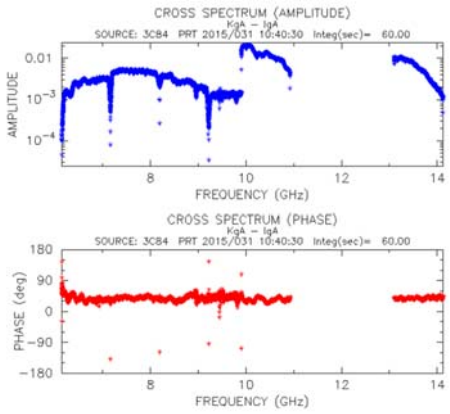
search function

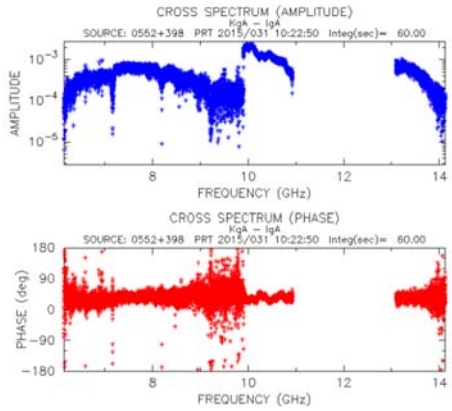


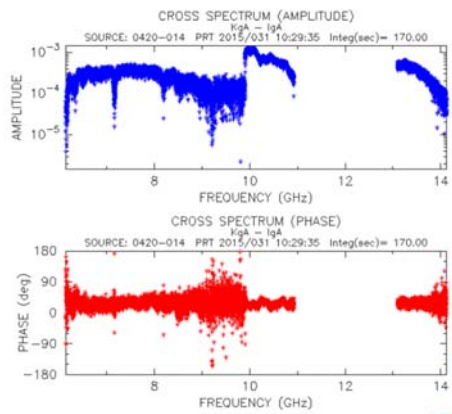
theoretical error is 27fs (femtosecons)

Examples of other scans



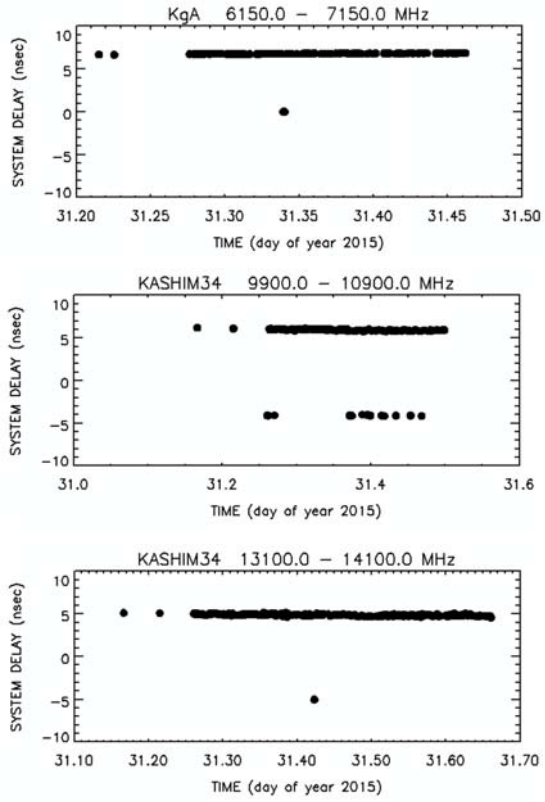




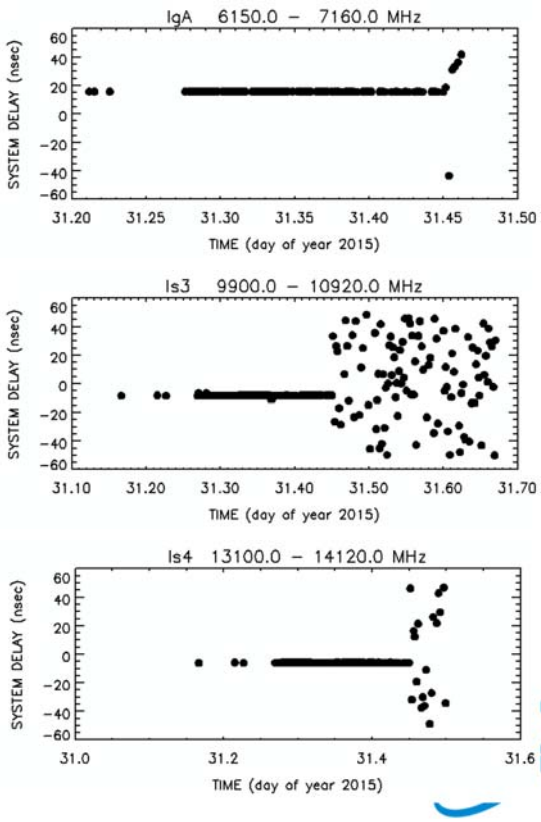


Evaluation of system stability by PCAL signals

Kashima



Ishioka



Conclusions

- establish a wide-band bandwidth synthesis technique without the use of PCAL signals
  - use PCAL signals to evaluate system stability
- compensation of ionosphere (estimation of TEC)
  - estimate the differential TEC against the reference scan using cross spectrum (phase spectrum)

Acknowledgements

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