Structure effects in broadband VGOS data

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24th EVGA Meeting
Gran Canaria, Spain, March 17-19, 2019

CONTENT

- Motivation and data
- Structure effects in group delay and phase observables
- Structure effects in amplitude observables at 4 frequency bands
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Motivation

- In order to approach the 1-mm VGOS position accuracy goal, four strategy plans were proposed:
  - Reduce the average source-switching interval
  - Reduce the random delay error of measurements
  - Reduce susceptibility to radio frequency interference
  - Reduce systematic errors (e.g., antenna deformations, source structure errors)

The observations from GGAO12M-WESTFORD have demonstrated the great improvement in the first three strategy plans, while the forth still remains as the main challenge (Niell et al., 2018).

Motivation

- Pedro Elosegui reported the results of CONT17 VGOS observations in the IVS meeting last year
  - Random delay measurement noises approaching just ps
  - Residuals of a large fraction of observations were really big (> 0.1 ns), source-based, systematic, and they have repeated patterns over 5 days
  - Some sources have to be deselected or down-weighted, such as 3C418, 3C371, 0229+131, 0552+398, and 2229+695.

We will focus mainly on the structure effects on CONT17 VGOS observations.

3 Dec. – 7 Dec., 2017

GGAO12M	Westford Antenna, Haystack Observatory, MA, USA
ISHIOKA	Ishioka VLBI Station, Japan
KOKEE12M	Kokee Park Geophysical Observatory, Kauai, HI, USA
WESTFORD	Westford Antenna, Haystack Observatory, MA, USA
WETTZ13S	Geodetic Observatory Wettzell, Germany
RAEGYEB	Astronomical Center at Yebes, Spain

Data

- Group delays and formal measurement noises:
  - Geocentric observables
  - Geodetic observables

- Phases
  - Total phases at the reference frequency (6 GHz), formal uncertainties derived from SNR
  - Residual phases at 8 channels of each 4 frequency bands, formal uncertainties for each frequency bands defined as the RMS of the phases at the 8 channels

- Amplitudes
  - Amplitudes at the reference frequency (6GHz), formal uncertainties derived from SNR
  - Amplitudes at 8 channels of each 4 frequency bands, formal uncertainties for each frequency bands defined as the RMS of the amplitudes at the 8 channels

Channel frequencies of CONT17 VGOS (GHz)

1	**3.032**	**3.064**	**3.096**	**3.224**	**3.320**	**3.384**	**3.448**	**3.480**
2	5.272	5.304	5.336	5.464	5.560	5.624	5.688	5.720
3	6.392	6.424	6.456	6.584	6.680	6.744	6.808	6.840
4	10.232	10.264	10.296	10.424	10.520	10.584	10.648	10.680

Structure effects in Group delays

0016+731
0059+581
3C371
3C418
0716+714
1300+580
2229+695
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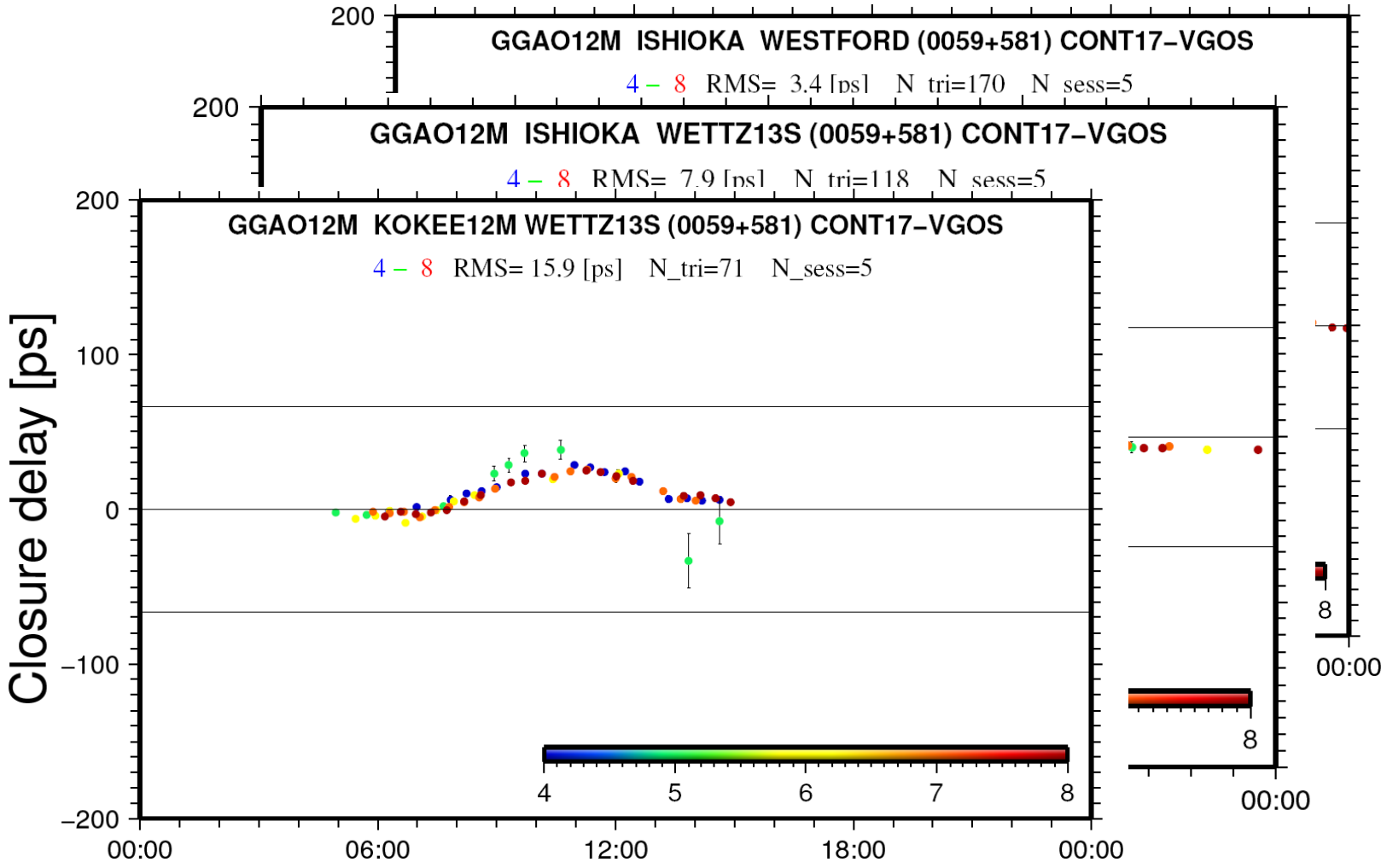

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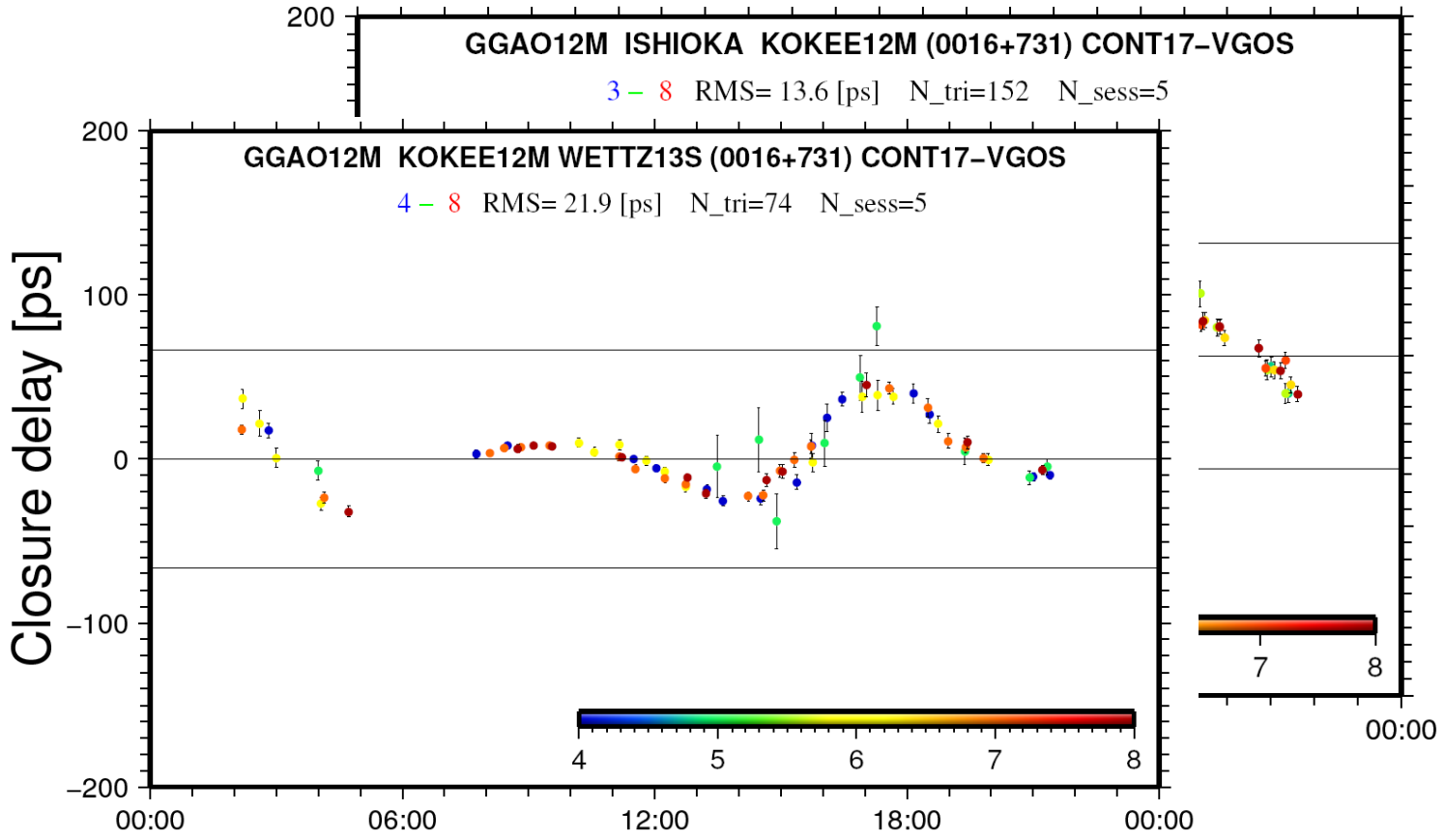

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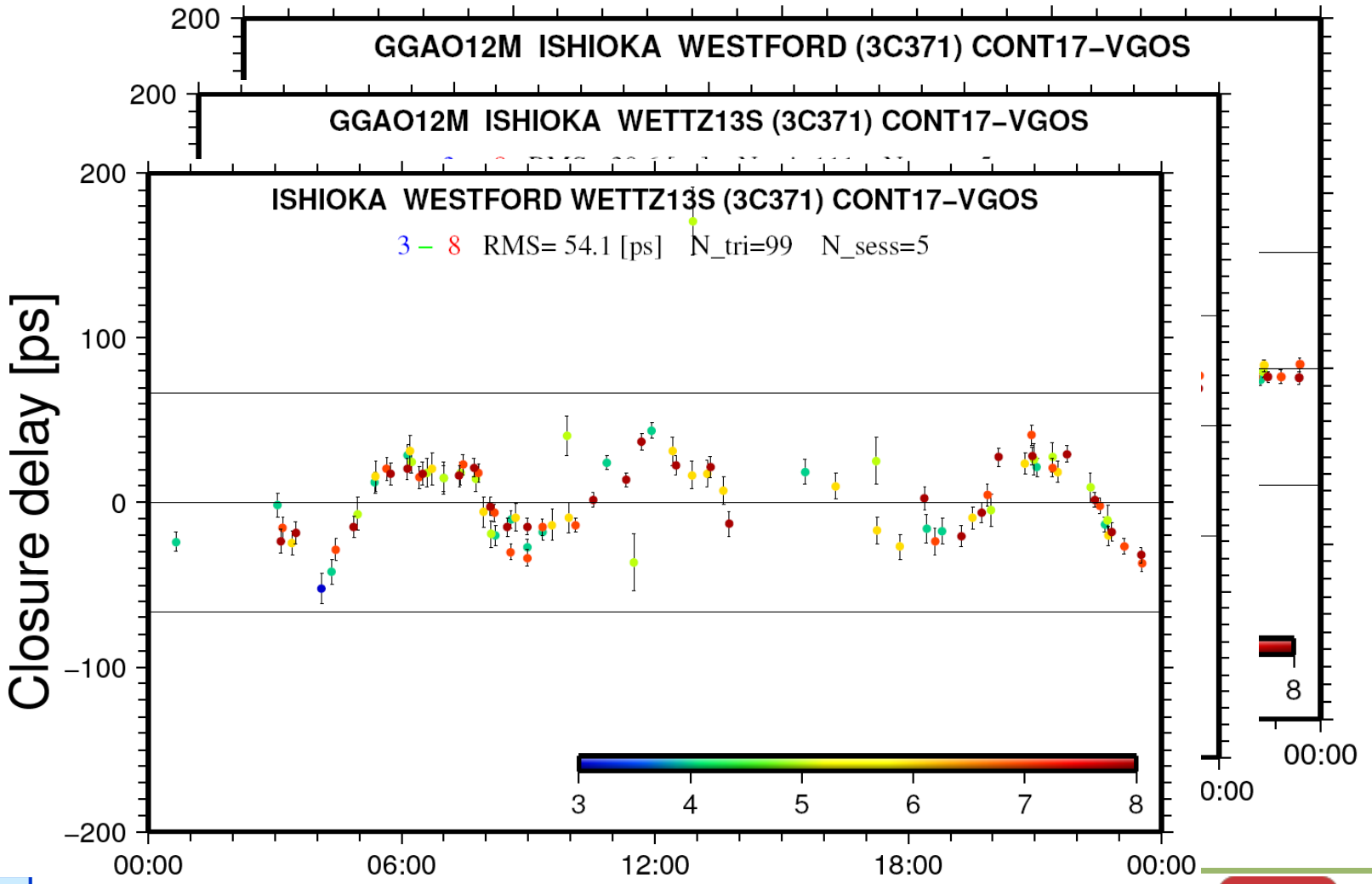

Structure effects in VGOS data – Xu et al.
24th EVGA Meeting, Spain, March 17-19, 2019

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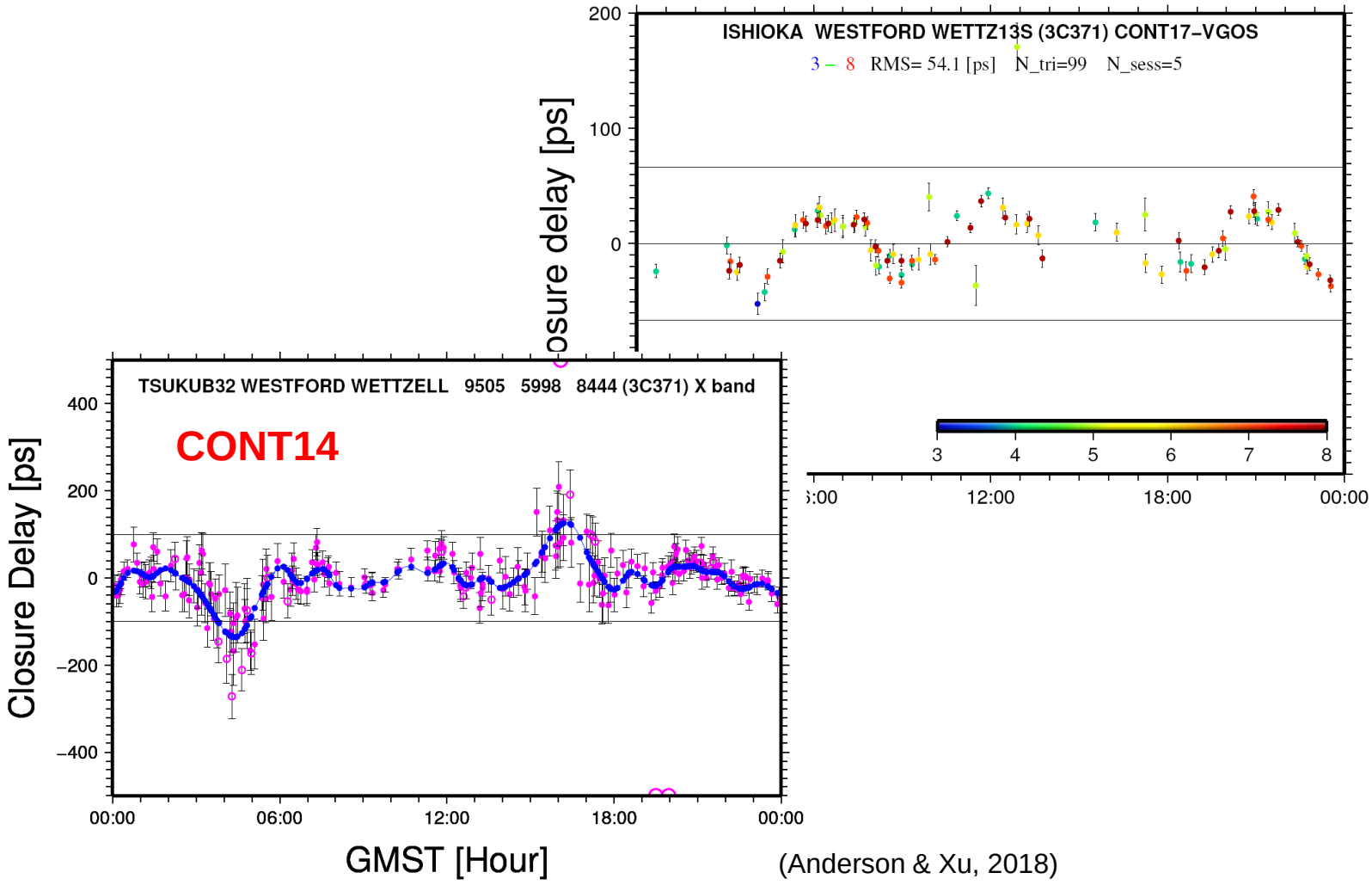

(Anderson & Xu, 2018)

Structure effects in phase and amplitude

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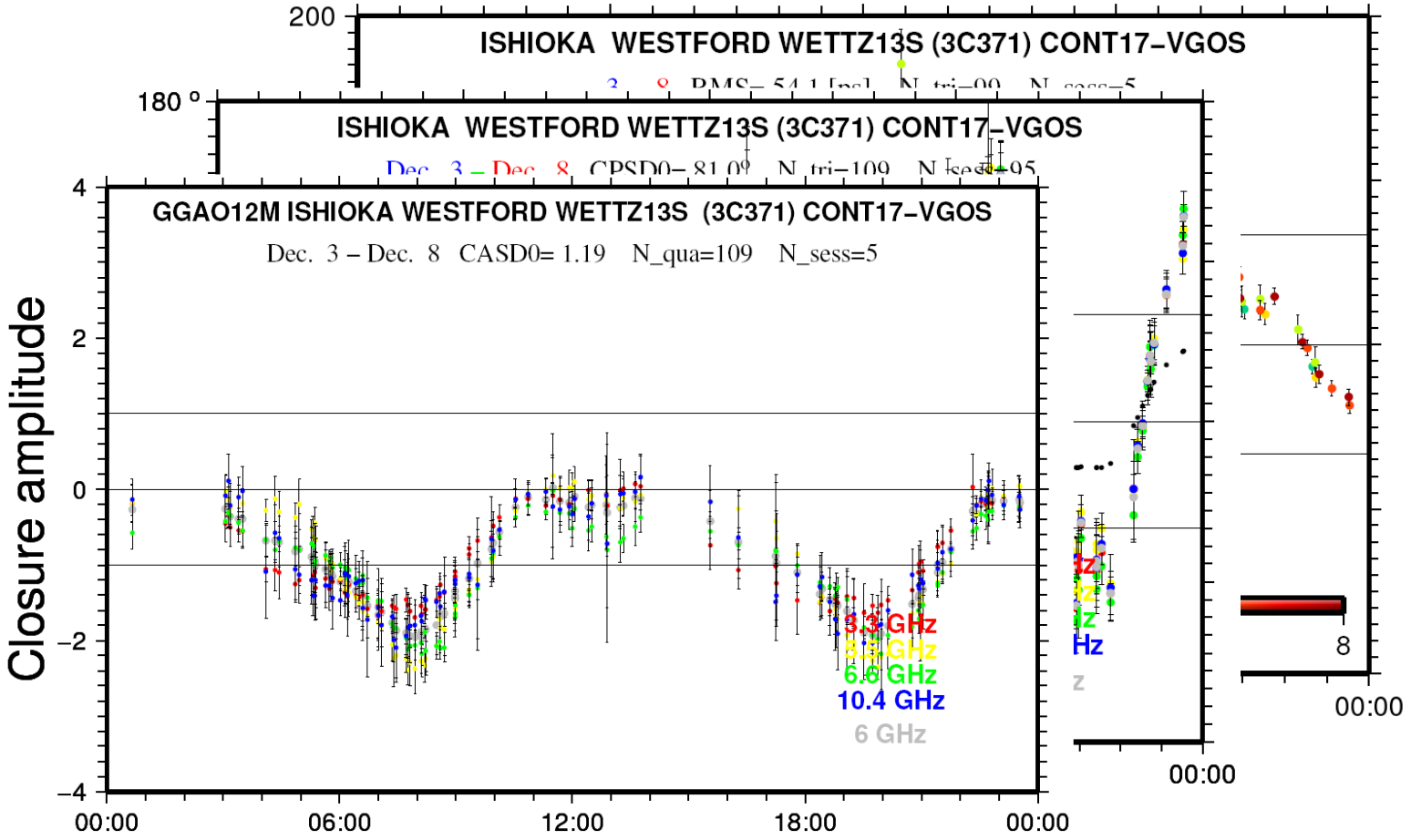

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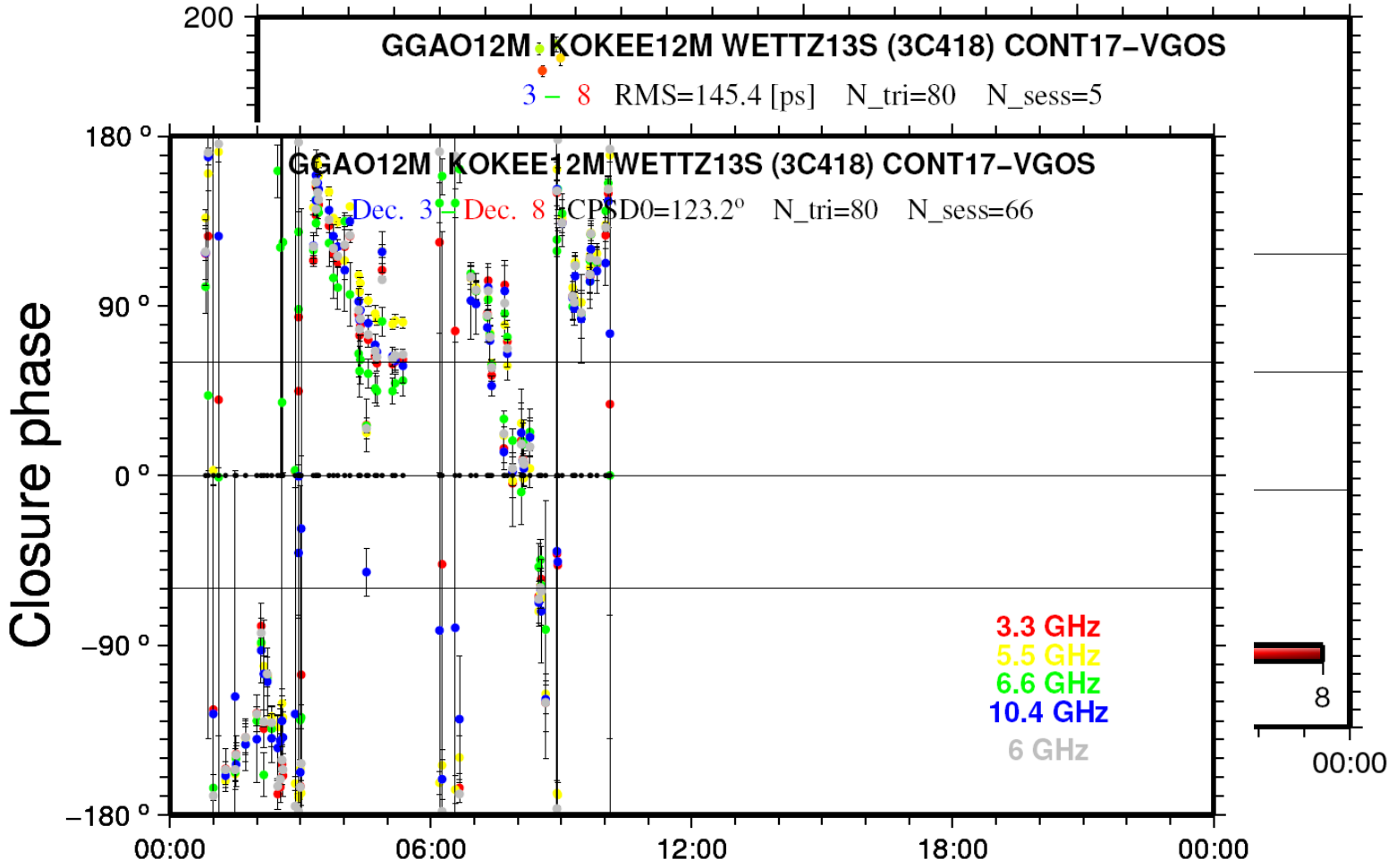

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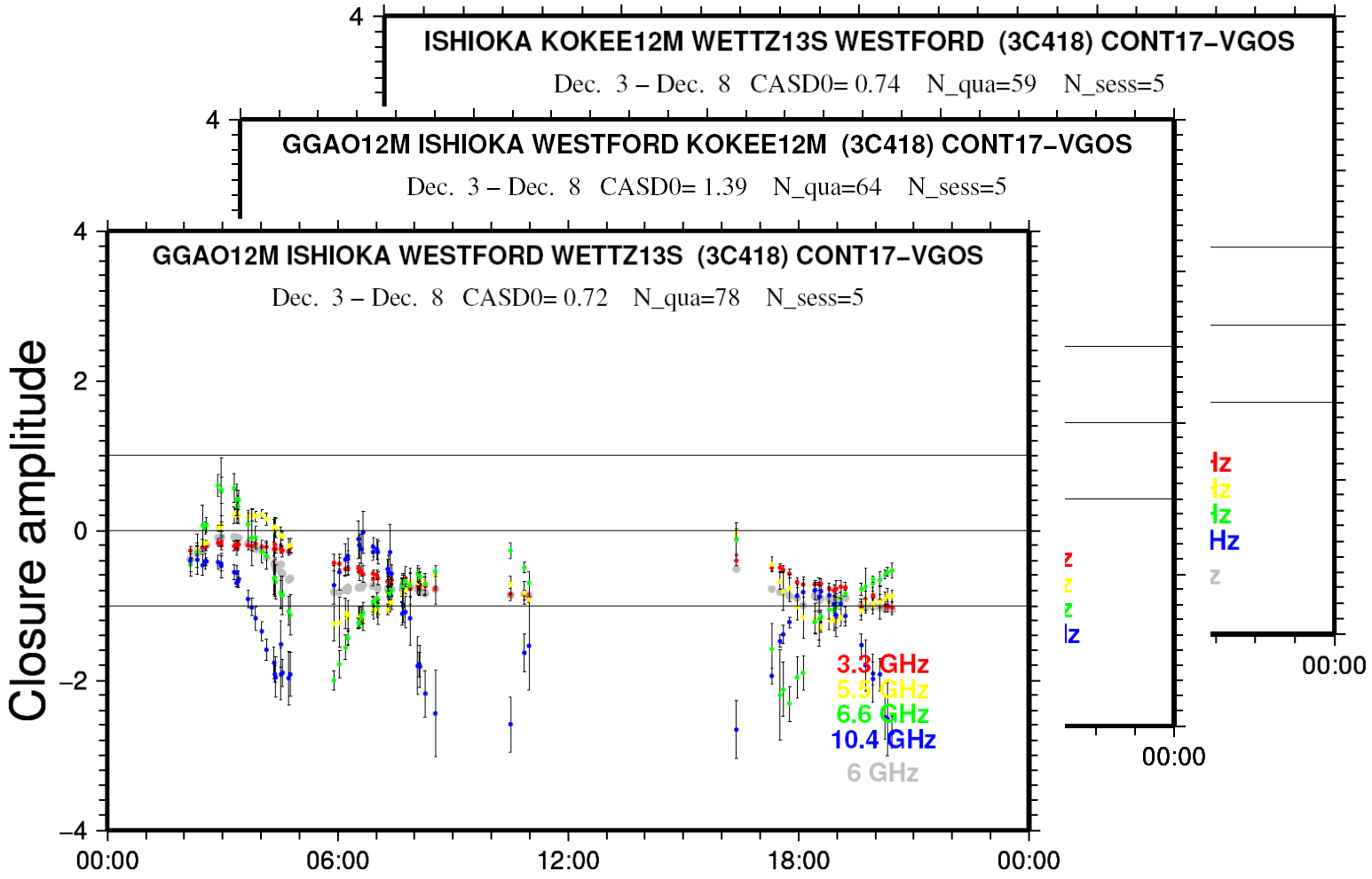

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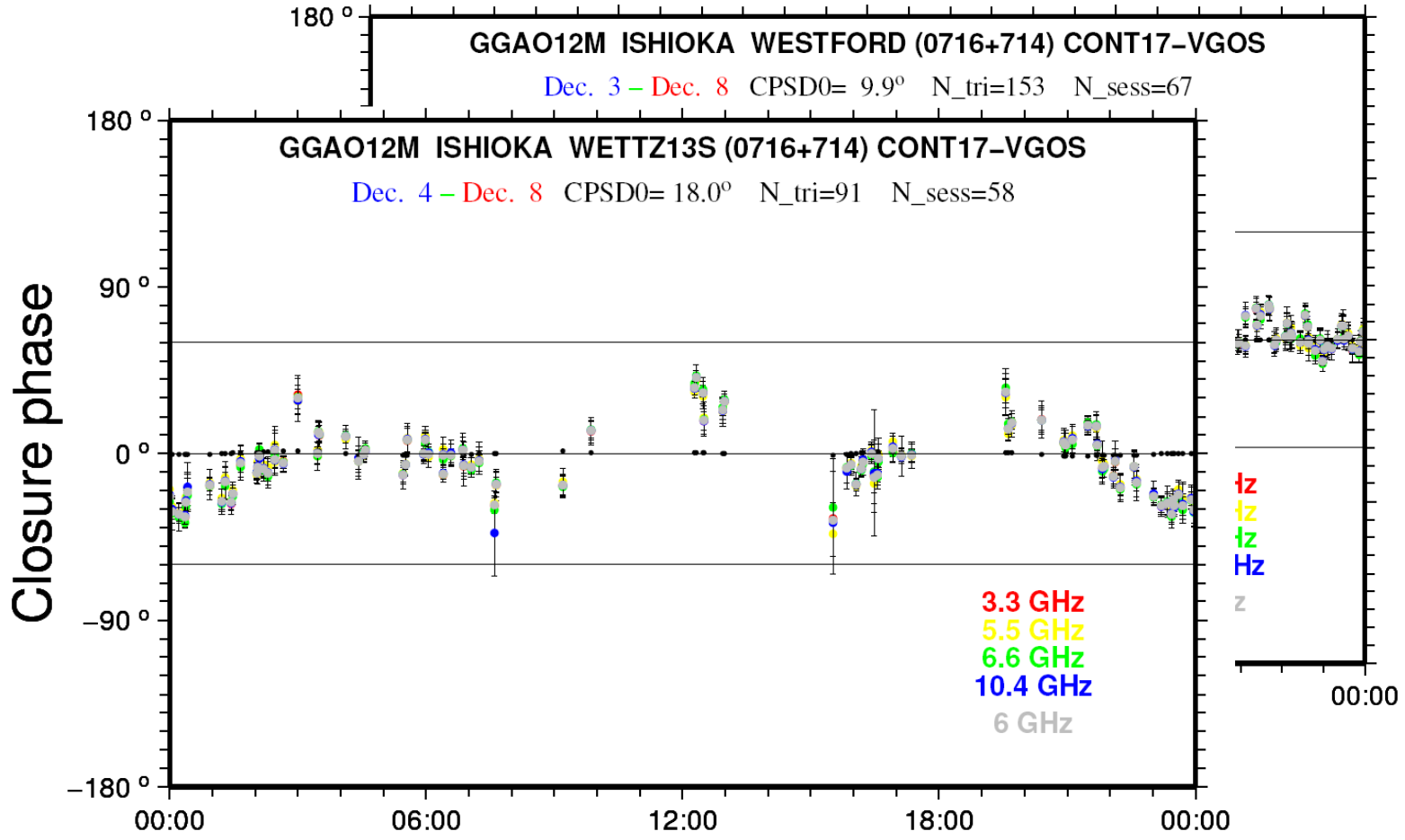

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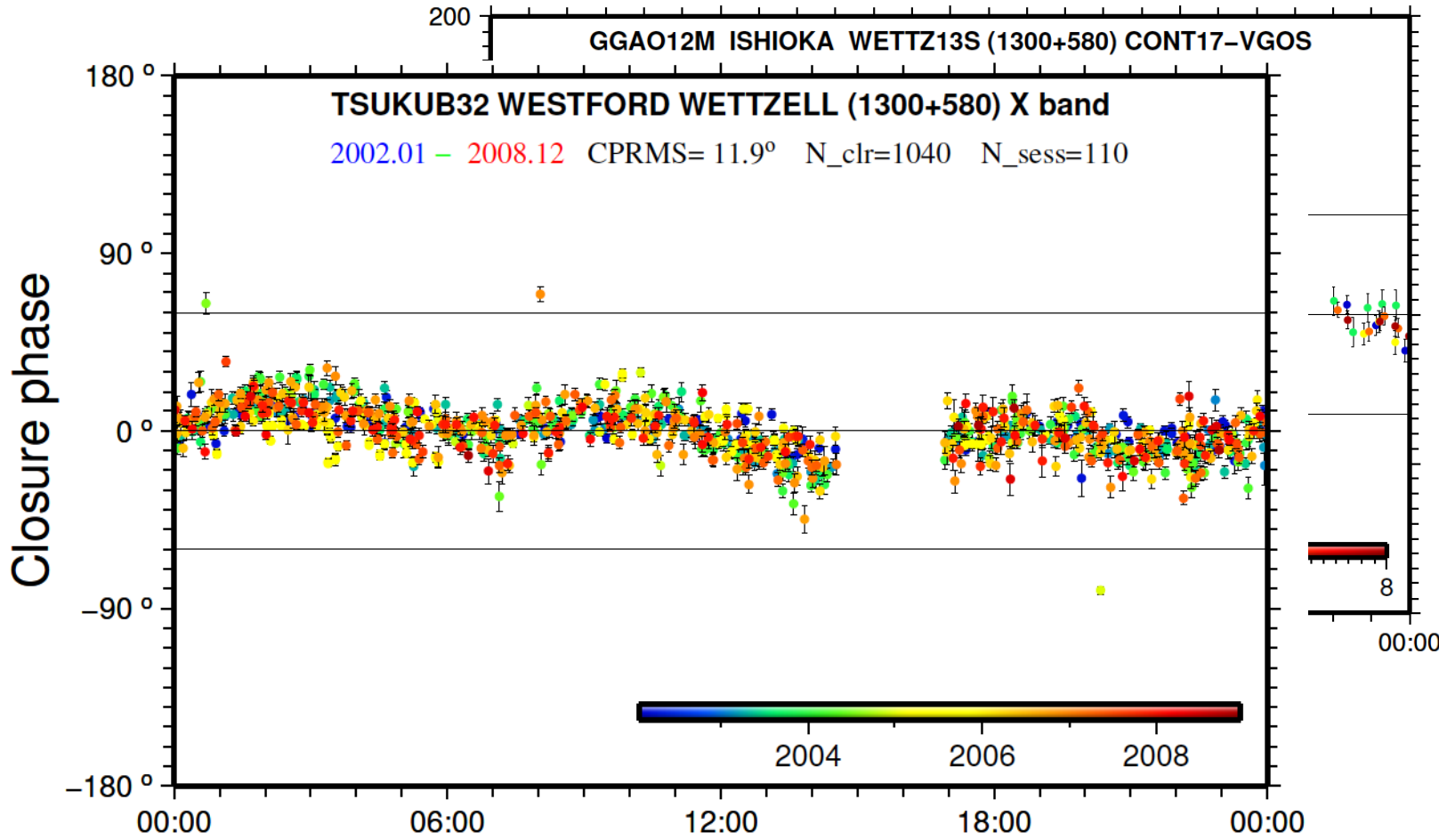

(Xu et al., submitted to ApJS, 2019)

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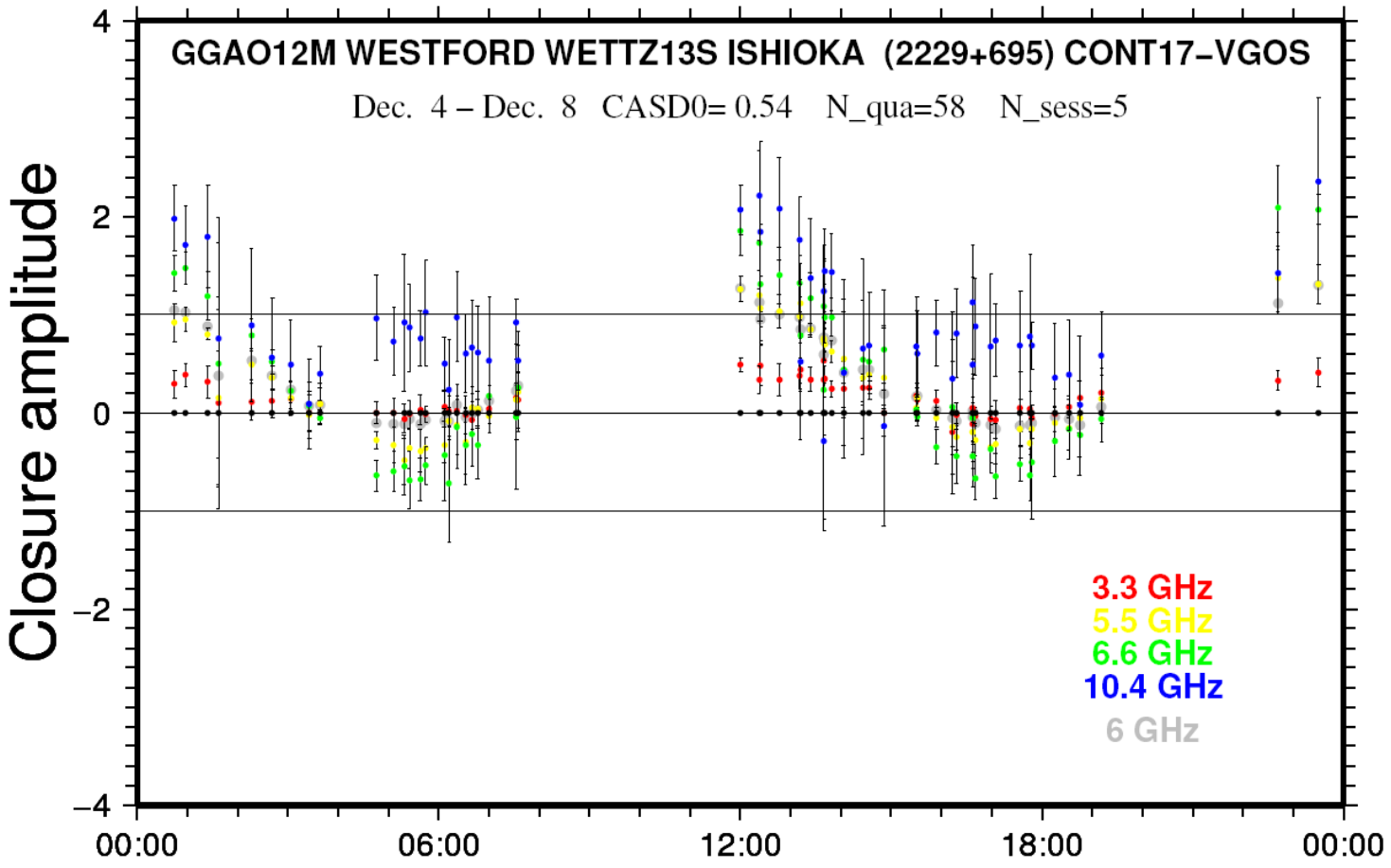

Larger error bars indicate either lower SNR or larger spectrum index (lager differences in structure across the band) at individual bands.

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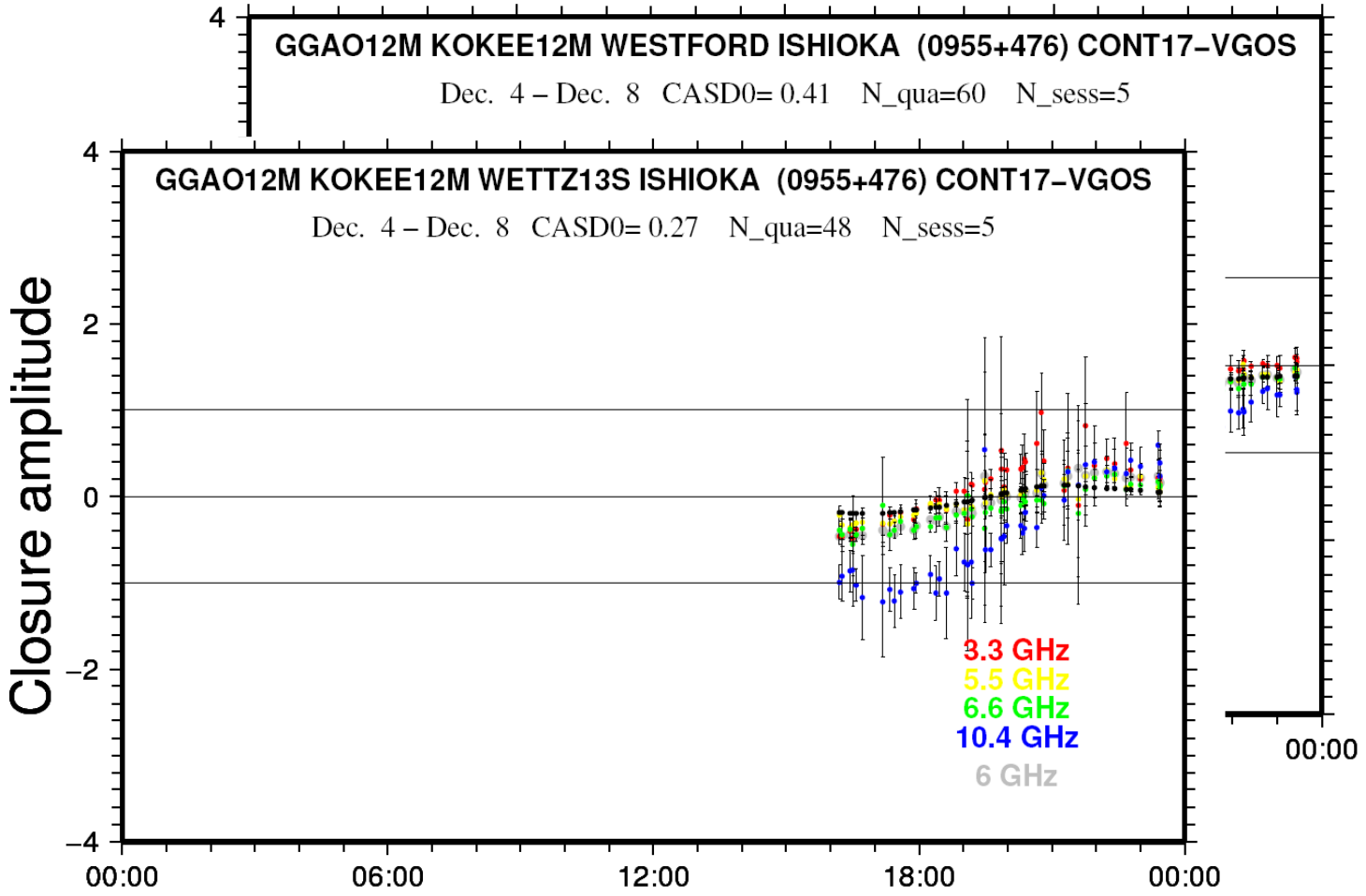

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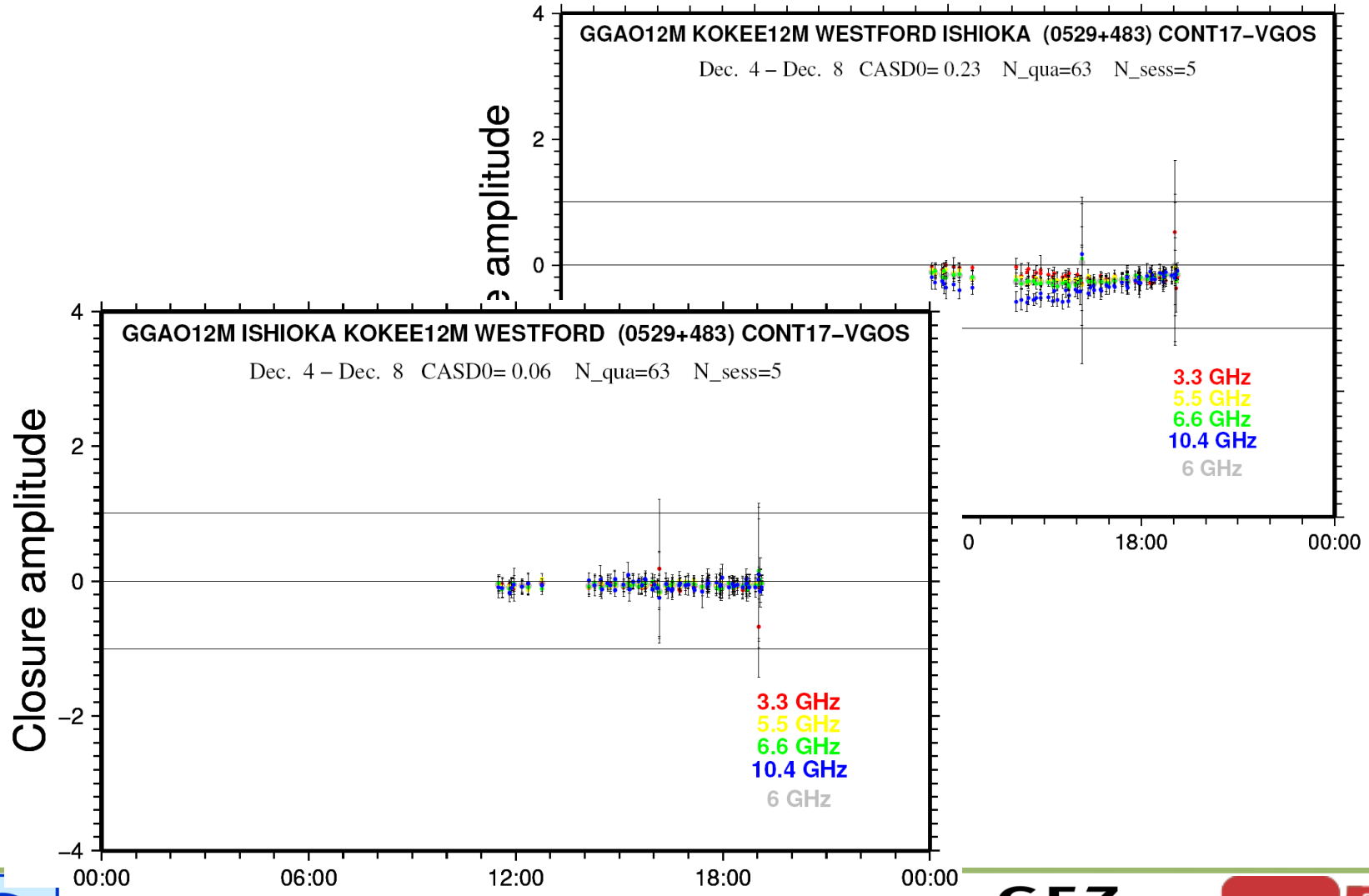

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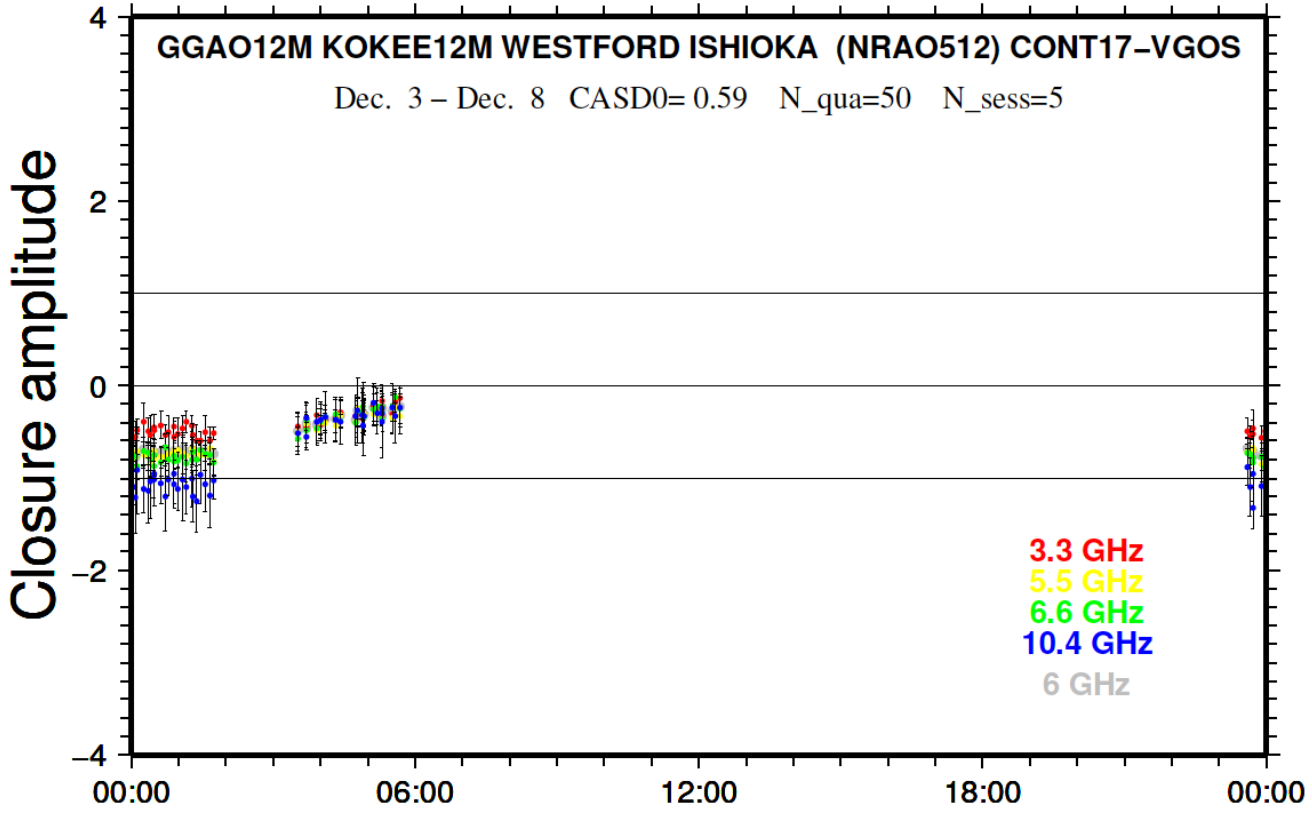

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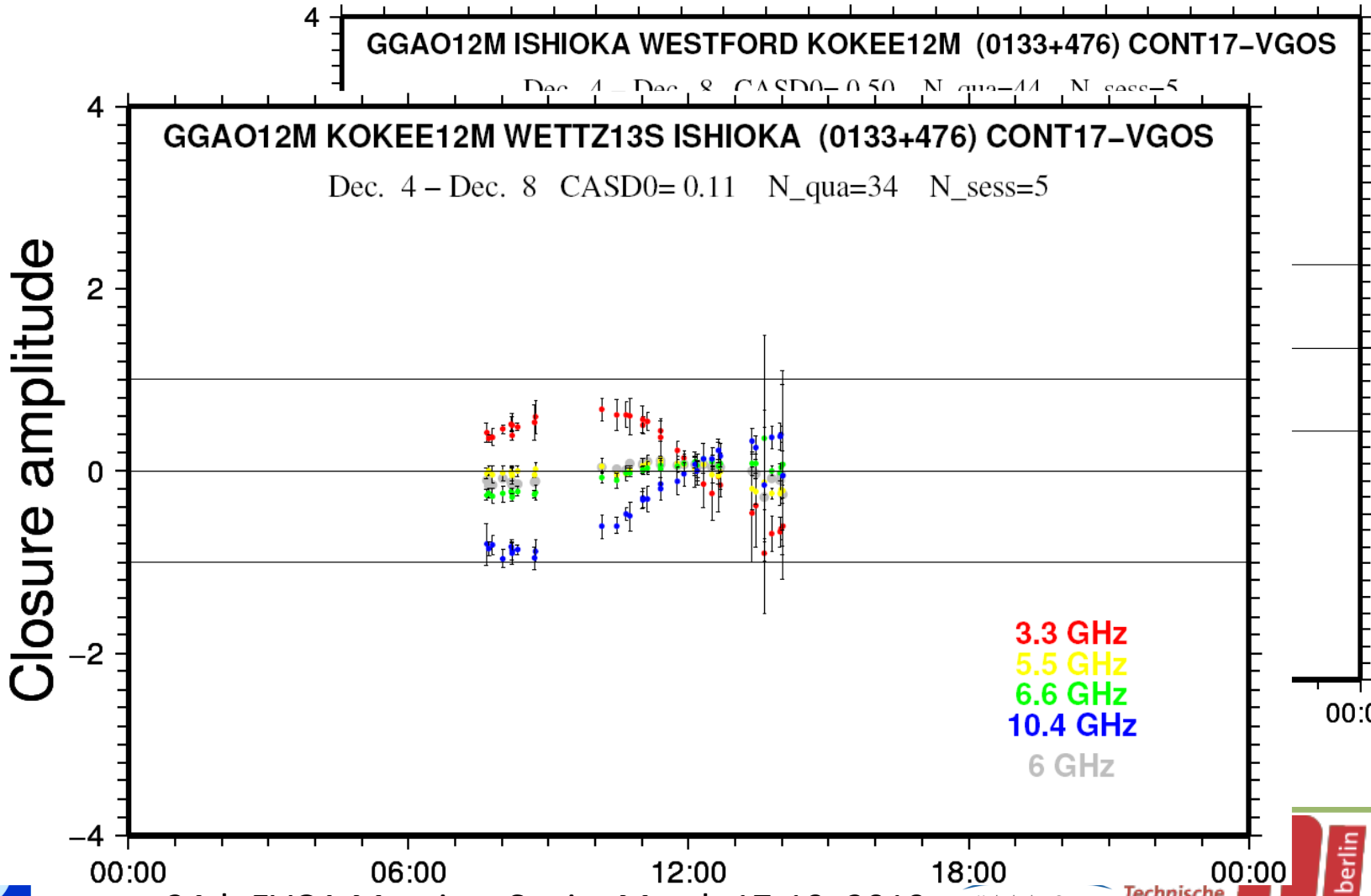

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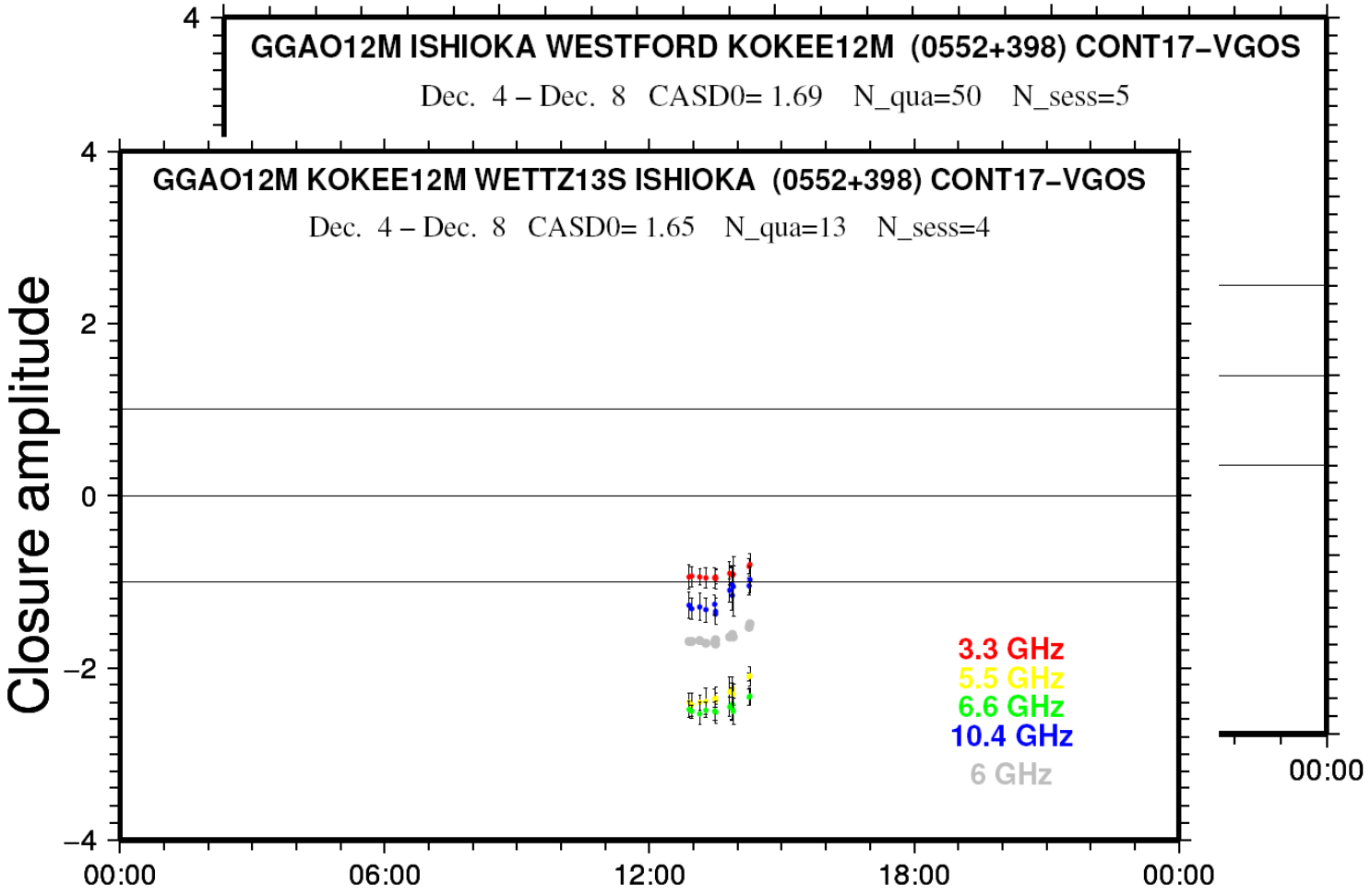

Summary

- Delay model of structure effects may not work for VGOS
- We need total phases at 8 channels of each frequency bands
- Structure effects are critical for extended sources for VGOS, for instance, in scheduling, correlator, and data analysis
- If VGOS intends to demonstrate its full potential for geodesy and astrometry, structure effects have to be removed

Thank you very much for your attention!

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Thanks to all IVS components that contributed to CONT17 VGOS data and make them available.

Channel frequencies for 4 bands

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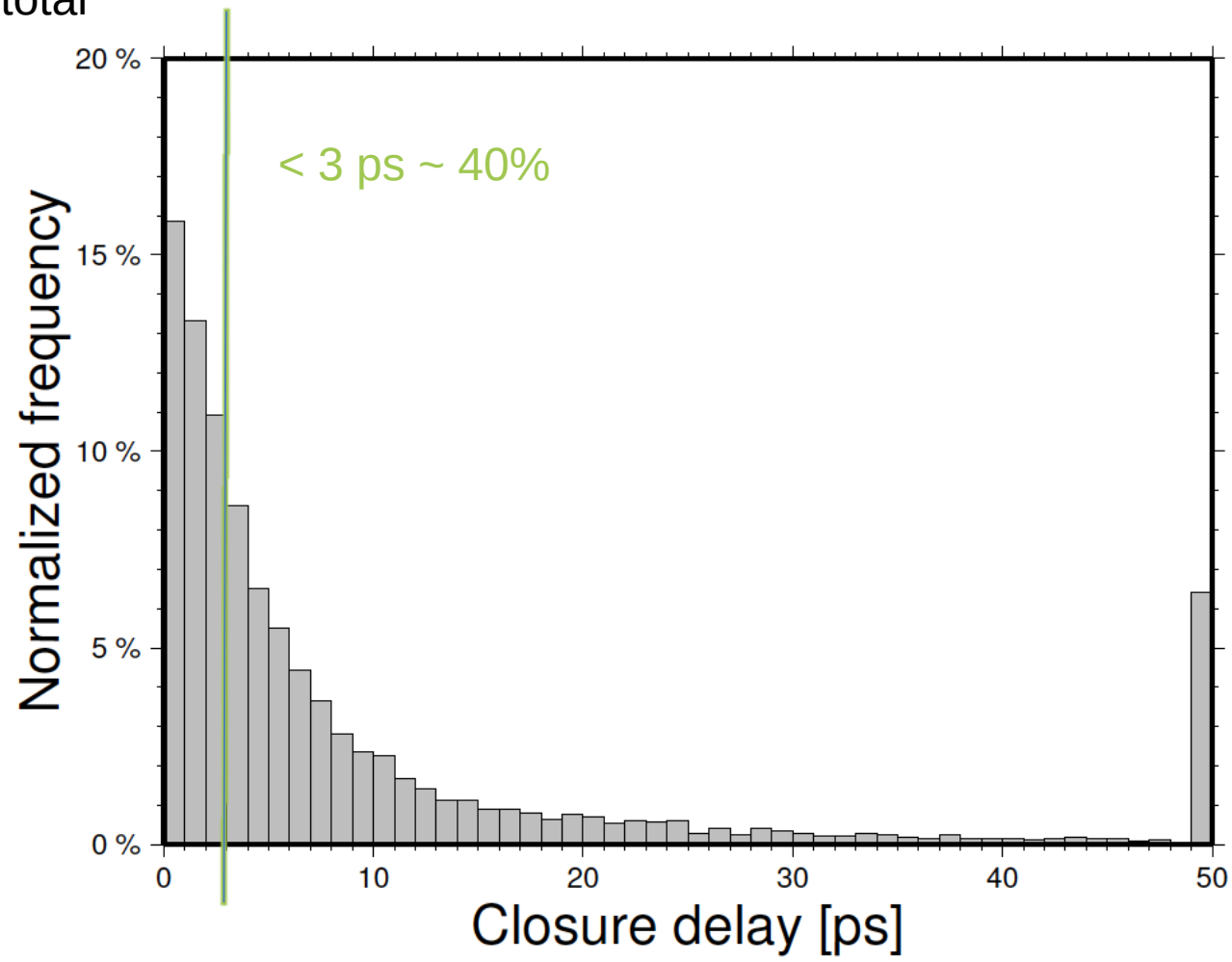
Distribution of closure delays

10,705 closure delays in total



Structure effects in phase

3C371