

Interactive comment on “An introduction to FY3 GNOS instrument and its performance tested on ground” by W. Bai et al.

W. Bai et al.

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Dear Referee #4 and editor,

Thank you for your comments concerning our manuscript entitled “An Introduction to FY3 GNOS Instrument and Its Performance Tested on Ground” (Manuscript Number: amt-2013-331). Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches. We have studied comments carefully and have made correction which we hope meet with approval. The responds to the comments are as flowing:

(1) P4, L19-22: On the occultation antenna, could you provide some description of the antenna design? If 10 dBi is the average gain over the field of view, what is the peak gain?
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gain?

Response: The occultation antennas were dual-frequency microstrip antennas, which were made up of 4 elements as antenna array, the peak gain were about 11.8 dBi (GPS L1/2), the average gain were about 10 dBi over the field of view.

(2) P4, L28-29: “An Ultra Stable Oscillator (USO) is used as a reference oscillator with very stable frequency (Allan variance of 10^{-12}): :.” Did you mean “Allan deviation” here? In addition, I think it'd be good to mention the integration time here, even though it's given in Table 1.

Response: Yes, it's good comment, the time is 1 second for the Allan deviation, it have been revised in new update paper.

(3) P5, L9-11: I'm confused about the GNSS terminology used here. What is meant by L2 C/A? Do you mean L2C? Can GNOS track L2C? Also are the codes for B1 and B2 same as the C/A code in GPS L1?

Response: It's a good question. L2 C/A meant L2C. I have replaced “L2 C/A” by “L2C”, replaced “B1 C/A” by “B1I”, and replaced “B2 C/A” by “B2I”, which is the same with BD's ICD, in the new update version paper. GNOS can track L2C and it can track L2C and L2P meanwhile. The codes for B1I and B2I are similar with GPS L1 C/A code, but there are also some differences, for example, the code period is half of GPS L1 C/A's. If you interested in it, I recommend you refer the Beidou's ICD, which you can download from website of China Satellite Navigation Office.

(4) P5, L12-14: Open-loop (OL) tracking is carried out for L1 only. Is there any reason that GNOS does not track B1 and/or B2 signals in OL as well?

Response: Yes, there are two reasons: 1. As I have mentioned, the code period of B1I and B2I is half of GPS L1 C/A's, and the one code chip length is about 150m. According the paper “Sokolovskiy, 2001”, the code model error caused ionosphere is almost 100m in the lower part of the troposphere, so the amount of this error exceed

half of B1I or B2I code chip length, it's tough to implement the OL, especially for the rising occultation events. 2. The open loop will result in large volume of raw data, because the limitation of the data downlink rate, GNOS just carry out the GPS L1 OL tracking in FY3-C. Fortunately, We plan to complete the GPS L1 and B1I OL tracking in next satellite FY3-D.

(5) P5, L14-17: Can you describe the onboard Doppler model used by GNOS during OL tracking? Do you track the code in OL as well?

Response: This has been revised in discussion version paper "amtd-7-703-2014.pdf", where I have describe both the Doppler and code OL model: "In open-loop tracking, the signal is down-converted using a numerically controlled oscillator, which generates a frequency given by an onboard Doppler model pre-calculated in GNOS without a feedback from received signal (Sokolovskiy, 2001; Sokolovskiy et al., 2009). Particularly, for the rising occultation, an a priori range model of the atmospheric delay (Ao et al., 2009) is also calculated onboard the GNOS."

(6) P6, L20: " : : simulator output SNR was 48 dB : : ." Did you mean dB-Hz?

Response: Yes, it means dB-Hz.

(7) P6, L21-24: What is the integration time for the code and phase noise? 1 second? Why is the precision worse for Beidou?

Response: It's a very good question. The noise integration time is 1ms, then when you would like to calculate the SNR, you should deduce the noise level to the corresponding signal integration time. We think the reasons of the worse precision of Beidou are as following: 1. The coherent integration time for BD signals is 2ms, with 20ms for GPS signals. Because the BD GEO's navigation code time for one bit is 2ms, we adopted this coherent time, which will reduce the precision of measurements. 2. Most important, we think the tracking loop type and parameter are the main reasons. We adopted FLL + PLL to track the GNSS signal in FY3-C, but the method is not perfect,

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we have been improving and testing, we would like to make it better in the next satellite FY3-D.

(8) P7, L16: "We succeed in retrieving the refractivity profiles : ." Please describe the inversion method used to retrieve refractivity.

Response: This has been revised in discussion version paper. We have complemented the introduction of retrieve method in section 4.2.

(9) P7, L22-29: It would be helpful to show a plot for the statistical comparisons.

Response: Yes, it's good advice. However, there will be a specific paper written by my colleague to introduce the mountain-based experiments, where there are the table and figure to describe the statistical comparisons. The paper is planed to submit. So for this paper, we would like to use mainly a macroscopic viewpoint to introduce GNOS.

(10) P8, L4-5: " : : we just carried out GNOS Beidou occultation functional test." What does "functional test" mean? Please explain.

Response: "functional test" means a test that helps you determine whether a system functions as intended. For this example, we think it means this mountain-based test to prove GNOS possess the function to receive the BD occultation events.

(11) P8, L5-8/ Fig. 9: Why is the Beidou case biased relative to the GPS closed loop case? A refractivity > 350 seems too large for a non-tropical site. It might be due to inversion errors. Please check.

Response: There are some reasons for the bias between GPS and BD closed loop case: 1. The two events (GPS and BD occultation events) were within half an hour, but not in the same time. 2. The two events were not occurred in the same direction, the azimuths were different (~186 degrees for B12 and ~150 degrees for G14), so, the two tangency point position of the two events were not the same. The furthest distance between the two occultation event tangent points were less than 100 km in the same height level. 3. We didn't get the BD precise ephemeris, so the position of BD satellite

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is not accurate. Especially, we used single-difference method to retrieve the ex-phase, the reference satellite is a GEO, the GEO position precision is worse, at least several meters. We think the big errors of BD satellite position may be the main reason for the bias.

We have checked the inversion processing again, we didn't find any mistakes. And we checked that day's weather condition, it was raining and fog, and the experiment spot was surrounded by a wealth of mountains, it is mountain climate, so I guess the large refractivity was caused by the weather condition in that moment.

Minor comments:

(12) P2, L26: Beyerle et al. 2005 should be referenced for GRACE occultation.

Response: Yes, I have modified it in the new update version paper.

(13) P2, L30: "even" -> "evenly"

Response: It has been revised in discussion version paper.

(14) P3, L9: "possess" -> "possesses"

Response: It has been modified in discussion version paper.

(15) P3, L11-12: "Scott Gleason et al." -> "Gleason and Gebre-Egziabher" (You might want to cite the specific chapter on RO.)

Response: It has been revised in discussion version paper.

(16) P3, L19: "Yanmeng et al." -> "Bi et al."

Response: It has been modified in discussion version paper.

(17) P4, L12: "bean" -> "beam"

Response: It has been revised in discussion version paper.

(18) P4, L20: remove "that"

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Response: It has been removed in discussion version paper.

(19) P5, L1, L5: "Multi-frequency" -> "multi-frequency" (lower case)

Response: It has been modified in discussion version paper

(20) P5, L25-26: "The average GRAS data rate is : : ." Did you mean "GNOS" here?

Response: It has been corrected in discussion version paper.

(21) P5, L29: what are equatorial crossing times of FY3?

Response: The FY3C is morning sun-synchronous satellite, the local time above Beijing is about 10:00am (local time), and the period time is about 104 min. The equatorial crossing times is shift every day, there are crossing times for one day: ~8:37, ~9:24, ~10:18, ~11:59, ~12:48, ~13:40, ~14:31, ~15:23, ~16:11, ~17:04, ~17:53

(22) P5, L32: spell out GEO, IGSO, and MEO

Response: They have been revised in the new update version paper.

(23) P6, L1: ": : : 24 hours, with considering: : ." -> "24 hours. Considering: : ."

Response: It has been corrected in discussion version paper.

(24) P6, L17: "Oliver et al." -> "Montenbruck et al."

Response: Yes, I have modified it in the new update version paper.

(25) P6, L28: "there dimensions" -> "three dimensions"

Response: It has been corrected in discussion version paper.

(26) P7, L8-9: "we can overlook the horizontal isn't hidden the landform in the southward view." Please rephrase.

Response: It has been revised in discussion version paper.

(27) P8, L8: "compare" -> "compared"

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Response: It has been corrected in discussion version paper.

(28) P8, L27-28: "Especially, GNOS first succeed in implementing Beidou mountain-based occultation explorer." Maybe rephrase as "In addition, we present results from the first Beidou mountain-based occultations from GNOS."

Response: It has been revised in discussion version paper.

(29) Figure 3 caption: "Beidou" should be "GPS"

Response: It has been corrected in discussion version paper.

(30) Figure 7: Please indicate in caption which way is South.

Response: Azimuth angle 180 deg is south direction. I have complemented it in the caption of Fig.7 in the new update version paper.

We have tried our best to revise and improve the manuscript and made great changes in the manuscript according to your invaluable comments. We appreciate for your warm work earnestly, and hope that the corrections will meet with approval.

The new update version paper is enclosed in supplement.

Thank you very much.

Yours sincerely,

Bai Weihua

Please also note the supplement to this comment:

<http://www.atmos-meas-tech-discuss.net/7/C610/2014/amtd-7-C610-2014-supplement.pdf>

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 703, 2014.