Report on GBOT's activities during OR3: Procedural course of events and an analysis of the obtained dataset

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Abstract

This Note describes the activities of the GBOT workpackage during the DPAC Operations Rehearsal 3 in detail, and discusses the outcome and occurring problems. Additionally (this leads beyond the actual scope of the OR3) the obtained data is subjected to an analysis. Finally, recommendations for the operational phase of the Gaia project for GBOT are issued.

Contents

1 Introduction

This is a report on the outcome of the GBOT section of the DPAC operations rehearsal No. 3 (OR3), officially lasting from April 22 - April 30, 2013, which was a third of a series of four such rehearsals aiming at demonstrating the readiness of those parts of DPAC which have to be operable at or soon after launch. This report is entirely focused on GBOT's activities and the resulting data, it is therefore much narrower in scope and more detailed than the official DPAC OR3 closeout report SE-039. The main aim of this report is to sum up all events, identify weaknesses and assess the obtained data in order to make suggestions for the operational phase.

At the time of the OR3 the launch date was set to be September 19, 2013[1]. This is the second OR, in which GBOT fully took part[2]. In the previous OR2, which took place in December 2012, GBOT participated with one telescope/institution, i.e. the Liverpool telescope taking observations. The outcome of this OR2 effort was overall successful, only small issues turned up during the operations (see ...). During this rehearsal, GBOT participated as intended with the two institutions which are foreseen to form the backbone of operations, namely the Liverpool telescope (LT), with one 2 m telescope on the Roque de los Muchachos observatory on La Palma (Canary Islands, Spain) and the Las Cumbres Optical Telescope (LCOGT) Network which currently runs facilities at CTIO (Chile), SAAO (South Africa), McDonald (Texas, USA). A further location, Siding Spring Observatory is being set up, and will - while not available during OR3[3] - be online at the start of operations[4]. As in previous occasions the main aspect will be the functioning of the GBOT network, i.e. communication, observations, data delivery, etc., rather than the quality of the astrometric results, which will be outside of specifications, due to the lack of suitable reference catalogue material[5]. Nonetheless, the data produced during this campaign will be used for a review of GBOT observing procedures, and this is subject in this report alongside with the formal aspects of GBOT operations. Sect. 2 gives details about the involvement of GBOT, mainly showing the internal document handed out to all participating bodies of the GBOT structure.

A difficulty, which GBOT faced during this OR was, that a large part of the dates during which OR3 was scheduled, was also covered by a full moon situation (see Tab. 1 and Fig. 5). On the one hand this gave us the opportunity to determine the full moon gap for the two telescope types, something which had been attempted many times, but not to the full level of satisfaction. A downside would have been the lack of really good data, therefore it was decided to start with GBOT activities one week earlier, i.e. on April 15, 12:00 UTC. The coordinates of Moon and Planck, the Lunar Phase and the distance between both objects are presented in Fig. 5 and Table 1.

[1] As of the time of writing (August 12, 2013), the launch date has been moved to November/December

[2] In OR1 (July 2012), GBOT participated on a small scale by delivering a dummy set of data

[3] In the meantime (August 12, 2013), this facility is up and running

[4] Further facilities may eventually be set up on Mount Teide (Teneriffa, Spain) and China in later times, depending on financing

[5] As described elsewhere, all data will be re-reduced when actual Gaia astrometry is available.

GBOT-OR3 Plan

April 2, 2013 (Martin Altmann)
Version 1.0β

Introduction

This document serves to communicate the OR3 schedule to all relevant parties (i.e. GBOT operations, Observatories, SOC, MOC) the road map which will be followed during the upcoming Operations Rehearsal 3 (22.4.-30.4.2013) based on the outcome of the GBOT-OR3 poll. Some still open issues are also listed; These will need to be addressed and solved by the initiation of GBOT's OR3 on Monday, April 15, 2013. activities form only applies to the GBOT related activities, i.e. a small part of the overall OR. This early start for GBOT is due to the Full Moon on April 25.

Basic information

Duration of DPAC Operations Rehearsal 3: Monday, April 22 – Tuesday, April 30
Full Moon: Thursday, April 25
European Holiday: May, 1st
GBOT – Begin of observations: Monday, April 15

<u>The observed target will be ESA's PLANCK satellite!</u>

Timeline

- April 15, 12UTC: initiation of GBOT activities, start of observations
- April 22: official start of DPAC Operations Rehearsal 3
- April 23: first delivery of GBOT data (TBC)
- April 24, 16:00 UTC (see below): 1st GBOT OR3 telecon
- April 25: Full Moon
- April 29, 16:00 UTC (see below): 2nd GBOT OR3 telecon
- April 30: 2nd delivery of GBOT data (TBC)
- April 30:end of DPAC OR3

FIGURE 1: Page 1 of GBOT OR3 plan, as handed out to observatories and other participators

Observatories & Telescopes

- LCOGT:
    - 1x 1m@MacDonald Observatory, Texas (elp), USA
        - *No MPC code – camera:* **kb74**
    - 3x 1m @CTIO (lsc), Chile
        - *W85 - Dome A – camera:* **kb78**
        - *W86 – Dome B – camera:* **kb73**
        - *W87 – Dome C – camera:* **kb77**
    - 3x 1m @SAAO (cpt), Sutherland, South Africa
        - *K91 – Dome A – camera:* **kb70**
        - *K92 – Dome B – camera:* **kb79**
        - *K93 – Dome C – camera:* **kb75**
- Liverpool: 2m Liverpool telescope with IO-cam
        - *J13*

Modus Operandi

- Start of Observations: Monday April 15, 2013, 12h UTC
- Observations to be conducted: 1 set of 10x30sec from **ONE** LCOGT telescope **and** the Liverpool telescope per 24 hrs, minimum tim
- espan between two LCOGT sets, 8 hrs, from April 15 – 30, the FM gap will be determined by the usefulness of data, symmetrical after FM

LCOGT Specifics

- Ephemeris will be optained through the JPL horizons system
- Data retrieval by GBOT: PENDING ISSUE. Please give status of script access problem. As of now the problem at IPAC is still open, see Section "Open Issues" -OI01
- Camera/Telecope identifiers needed for the data retrieval-OI02-SOLVED

Liverpool Telescope Specifics

- Ephemeris data to be obtained via GBOT FOV finder – Access to HD mirror needs to be solved by Paris/Heidelberg-OI03
- Data retrieval by GBOT via script, as done in OR2 using `gbot_search.php`

FIGURE 2: Page 2 of GBOT OR3 plan, as handed out to observatories and other participators

GBOT main control centre in Paris

Please edit, comment , add if anything is not correct:

- Newest Database and Pipeline: Ready
- FOV finder ready and independent from Horizons
- FOV finder in Heidelberg ready - at current not accessible from outside of Paris and Heidelberg due to restrictions in Heidelberg – solution found – implementation partial-OI03
- Retrieval of LT data from Archive: available
- Retrieval scripts to obtain data from IPAC: problem with IPAC is not yet finally resolved-workaround foundOI01
- Data transfer to SOC:
  On the following dates an OPTO/OPTT files will be sent to SOC.
  - #1 Tue, April 23 – Confirmed by SOC-OI04-SOLVED
  - #2 Tue, April 30 – Confirmed by SOC-OI04-SOLVED
- Ephemeris transfer from SOC to GBOT-DB: ready

Communication during OR3

- Between Paris and GBOT coordinator: daily telecon at 16:30 (weekdays only)
  - depending on the flow of things, this can be relaxed to once every two days
  - duration should be limited to 10-15 minutes if operations are nominal
- Between Paris, coordinator, SOC and observatories: two telecons during OR3:
  - Wednesday, April 24, 18:00 CEST, 17:00 UKST, 16:00 UTC, 09:00 PDT
  - Monday, April 29, 18:00 CEST, 17:00 UKST, 16:00 UTC, 10:00 MDT, 09:00 PDT

Open Issues

This Section includes details on everything highlighted in yellow in the other Sections. These points need to be addressed and best resolved by the start of GBOT's OR3 activities on April 15. Currently there are 4 open issues. The gravities of these issues could be: MINOR, MODERATE, MAJOR, SEVERE, depending how large the impact would be if not resolved. At current there is no SEVERE pending issue.

- OI01: Data transfer from LCOGT to the GBOT-DB – MODERATE:
  - In principle the LCOGT archives, hosted at IPAC/Caltech can be accessed via scripts of wget type or similar. However this does at current not work, and by end of the poll this has not been resolved by IPAC. Since this is out of the hands of either party we may need a workaround, either by manual retrieval using the webform (which works) – precise route of actions will be determined by GBOT in interaction with Tim Brown and Tim Lister. This OI is listed as MODERATE since a way of retrieval is available.
- OI02: Identifier of LCOGT telescopes/cameras – SOLVED:
  - In order to only retrieve the actual data, GBOT needs some unique identifyer keywords to separate this from skycam data, one of these could be the detector designation (“kb##”) or

FIGURE 3: Page 3 of GBOT OR3 plan, as handed out to observatories and other participators

the MPC location identifier. Will be addressed by GBOT coordinator and LCOGT. This OI has been labeled MAJOR since this is necessary information

- OI03: Access to Heidelberg FOV mirror – MINOR/PARTIALLY SOLVED:
  - While the Heidelberg FOV-finder mirror is up and running, it is at current not accessible from anywhere outside of `ari.uni-heidelberg.de` and `obspm.fr.` The reason behind this are restrictions within the Heidelberg domain. Preferred possible solutions are: Opening ports for all relevant IPs on a domain level or password protection. Solutions will be developed by HD sysadmin Peter Schwekendiek, the GBOT Coordinator and GBOT Operations, namely Teddy Carlucci. This is a MINOR OI, since we are not testing a Paris infrastructure failure, therefore the HD-mirror will only be used in the case of a real problem in Paris and there are other fallback options at this moment (JPL horizons)
- OI04: Delivery of OPTO/OPTT files from GBOT to SOC – SOLVED:

FIGURE 4: Page 4 of GBOT OR3 plan, as handed out to observatories and other participators

2 The GBOT OR3 plan

Shown in Figures 1 through 4 is the original GBOT plan for its activities during the OR3. We've chosen to include this plan as figures, rather than adapt this into the regular text of this report, to show exactly what has been used during the OR3 exercise, including the actual makeup of the text. **Please note that the "Open Issues" as mentioned in this plan reflect the status from shortly before the begin of OR3 (some are entirely OR3 related, and not of any relevance afterwards), and the status of these issues may or may not be different now, at the time of writing.**

3 Results

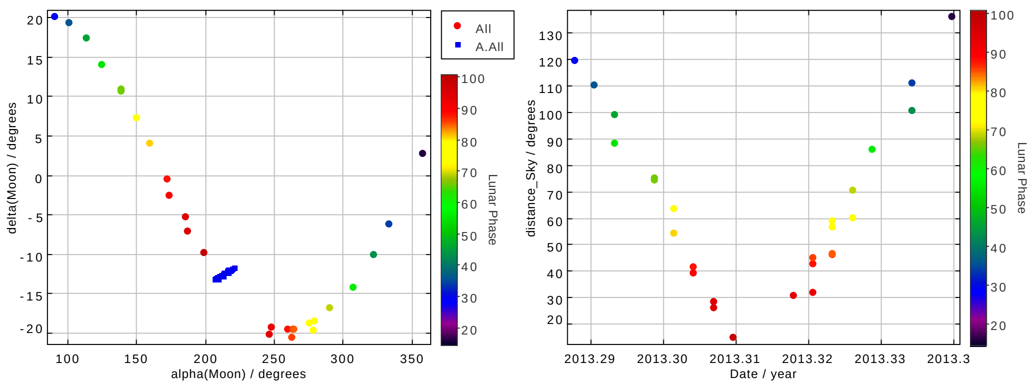

FIGURE 5: Presentation of the ephemeridal situation during OR3, as taken or derived from Tab. 1. The left panel shows the trajectories of Moon (coloured circular dots) and Planck (blue squares). The former symbols are colour coded according to lunar phase, with black being the lowest and dark red the highest phase (i.e. Full Moon). The right panel shows the distance between both objects during the observations. Again the colour coding is according to lunar phase. In both panels the deviations of data points from a smooth curve are caused by parallax - the data come from observatories from different geographical coordinates, especially latitudes.

Please note that this report reflects the view of GBOT, there will be an official DPAC report covering the complete rehearsal which will also contain a section on the performance of GBOT as seen from the DPAC point of view. While unlikely, the two reports may differ in certain points and may also reflect conflicting opinions on issues.

3.1 Procedural results

The overall outcome of this rehearsal was positive, the communication between SOC, GBOT and the observatories was mostly fluent and unproblematic. The few glitches and suggestions for their mitigation are given in Sect. 4. Three deliveries of OPTO/OPTT files were made, one

TABLE 1: The trajectories of Moon and Planck across the sky during OR3. LP means lunar phase. The lunar values have been derived using `xephem`. The observatories involved are represented by their official MPC codes, W85=LCOGT CTIO unit 1, K91=LCOGT SAAO unit 1, J13=Liverpool telescope

Date	UTC	Tel	α(Moon)	δ(Moon)	Az(Moon)	el(Moon)	$Vmag_{\rm Moon}$	LP	α(Planck)	δ(Planck)
2013-04-16	05:20:46.696	W85	06:01:40.7	+20:01:40.7	272:41:59	−38:09:08	−11	29	13:48:37.4	−13:12:57.2
2013-04-17	01:35:49.766	W85	06:43:45.7	+19:16:42.0	304:14:32	+15:59:12	−11	36	13:51:40.6	−13:08:29.4
2013-04-18	01:50:00.581	W85	07:33:48.8	+17:17:15.3	308:07:12	+22:53:37	−12	46	13:54:26.4	−13:04:17.4
2013-04-18	23:36:41.184	J13	08:17:40.5	+13:54:56.3	267:52:19	+33:42:29	−12	55	13:56:44.9	−13:14:02.0
2013-04-20	03:19:46.493	W85	09:13:54.6	+10:52:42.8	303:22:10	+27:42:27	−12	66	13:59:56.9	−12:55:45.1
2013-04-20	04:46:25.057	W85	09:16:12.5	+10:36:18.5	289:30:22	+11:32:32	−12	66	13:59:49.0	−12:55:40.8
2013-04-21	01:57:35.101	W85	10:01:03.7	+07:08:33.3	332:55:43	+49:10:49	−12	74	14:02:51.1	−12:50:58.6
2013-04-21	19:32:26.486	K91	10:37:38.9	+03:58:15.2	352:39:38	+53:29:47	−12	81	14:04:57.8	−12:47:00.2
2013-04-22	19:29:18.365	K91	11:28:11.4	−00:38:31.5	15:06:49	+57:26:49	−13	88	14:07:48.7	−12:42:23.4
2013-04-22	23:46:58.858	J13	11:35:54.6	−02:38:34.1	208:38:53	+55:10:44	−13	90	14:08:02.7	−12:55:51.2
2013-04-23	19:28:19.869	K91	12:20:35.3	−05:21:04.5	39:36:52	+56:59:40	−13	95	14:10:40.6	−12:37:44.4
2013-04-23	23:50:57.667	J13	12:28:49.5	−07:12:29.9	187:49:01	+53:41:31	−13	95	14:10:54.0	−12:51:11.5
2013-04-24	19:26:42.605	K91	13:15:23.3	−09:52:19.3	61:38:36	+51:48:05	−13	99	14:13:32.6	−12:33:01.4
2013-04-27	23:19:46.293	J13	16:25:32.8	−20:16:55.8	124:04:57	+15:20:19	−13	94	14:22:07.0	−12:31:44.8
2013-04-28	01:24:57.814	W85	16:31:29.1	−19:19:58.9	103:02:40	+16:46:46	−13	93	14:22:52.3	−12:17:35.2
2013-04-28	19:23:42.847	K91	17:18:36.9	−19:38:57.4	107:22:36	+09:30:39	−13	88	14:24:57.8	−12:13:19.9
2013-04-28	23:23:28.939	J13	17:29:02.0	−20:41:10.4	116:34:43	+04:39:39	−13	86	14:25:12.7	−12:26:39.1
2013-04-29	01:27:45.196	W85	17:34:33.6	−19:36:53.7	109:43:08	+05:19:28	−13	86	14:25:41.8	−12:12:30.2
2013-04-29	02:13:39.397	W85	17:36:33.4	−19:39:34.0	104:41:52	+14:20:28	−13	85	14:25:39.4	−12:12:41.4
2013-04-29	19:23:33.315	K91	18:20:48.0	−18:53:55.4	114:18:37	−01:27:58	−12	79	14:27:46.3	−12:08:07.8
2013-04-29	23:21:34.663	J13	18:31:12.2	−19:42:08.0	108:33:44	−07:07:32	−12	77	14:28:01.0	−12:21:25.9
2013-04-30	01:26:19.503	W85	18:36:13.6	−18:31:45.1	116:19:52	−07:09:00	−12	76	14:28:29.8	−12:07:15.6
2013-04-30	19:23:11.147	K91	19:20:48.6	−16:53:53.6	121:06:03	−14:19:18	−12	69	14:30:32.9	−12:02:49.2
2013-05-01	23:18:06.636	J13	20:27:46.3	−14:19:39.3	91:02:45	−28:55:14	−12	56	14:33:31.7	−12:10:41.5
2013-05-03	01:38:12.086	J13	21:27:28.4	−10:09:05.3	96:52:47	−08:31:47	−12	43	14:36:00.0	−12:04:54.5
2013-05-03	22:35:50.998	J13	22:10:56.1	−06:19:02.8	57:30:20	−53:41:36	−11	34	14:38:54.2	−11:59:42.0
2013-05-05	23:12:35.712	J13	23:50:21.3	+02:38:52.8	29:26:12	−54:45:51	−11	16	14:44:10.3	−11:48:45.4

TABLE 2: Statistic results of the observing sequences obtained for OR3. Note the low magnitude of Planck during the official part of OR3 and the brighter than usual one afterwards. The magnitude point of 15.5 for the observations of the Liverpool telescope on April 22 is bogus, since Planck was very close to a bright star (this dataset was not delivered)

Date	UTC	Tel	filter	$O-C_\alpha$	$O-C_\delta$	$\sigma_{O-C}(\alpha)$	$\sigma_{O-C}(\delta)$	$\overline{S/N}$	NI	NT	$\overline{mag}$	$\sigma(mag)$	MJD
2013-04-16	05:20:46.696	W85	rp	0.094	-0.588	0.115	0.041	40.8	20	10	19.18	0.16	56398.21234274
2013-04-17	01:35:49.766	W85	rp	0.091	-0.588	0.093	0.076	40.9	10	9	19.13	0.08	56399.06328249
2013-04-18	01:50:00.581	W85	rp	-0.139	-0.538	0.154	0.106	44.9	20	9	19.19	0.08	56400.07003211
2013-04-18	23:36:41.184	J13	$r_{\rm SDSS}$	0.064	-0.703	0.022	0.022	51.0	10	8	19.21	0.12	56400.98750861
2013-04-20	03:19:46.493	W85	rp	0.229	-0.682	0.078	0.080	45.4	10	10	19.04	0.05	56402.13526341
2013-04-20	04:46:25.057	W85	w	0.188	-0.725	0.066	0.025	87.6	10	7	19.12	0.03	56402.19531079
2013-04-21	01:57:35.101	W85	rp	-0.039	-0.897	0.065	0.053	57.2	40	17	18.88	0.13	56403.02757748
2013-04-21	19:32:26.486	K91	rp	0.027	-1.044	0.085	0.048	52.9	20	9	18.81	0.12	56403.80990853
2013-04-22	19:29:18.365	K91	rp	0.245	-1.139	0.142	0.092	59.9	20	8	18.79	0.19	56404.80641387
2013-04-22	23:46:58.858	J13	$r_{\rm SDSS}$	0.601	-0.860	0.325	0.007	265.0	10	2	15.5*	–	56404.99311061
2013-04-23	19:28:19.869	K91	rp	-0.045	0.104	0.144	0.160	60.9	20	10	18.77	0.15	56405.80645950
2013-04-23	23:50:57.667	J13	$r_{\rm SDSS}$	0.010	0.037	0.080	0.184	53.6	9	5	18.71	0.44	56405.99783461
2013-04-24	19:26:42.605	K91	rp	-0.014	0.165	0.088	0.221	70.3	10	2	18.76	0.27	56406.80650199
2013-04-27	23:19:46.293	J13	$r_{\rm SDSS}$	0.213	0.149	0.098	0.084	67.5	10	7	18.53	0.15	56409.97540262
2013-04-28	01:24:57.814	W85	rp	-0.032	0.111	0.111	0.151	68.0	10	6	18.65	0.14	56410.05651885
2013-04-28	19:23:42.847	K91	rp	0.231	0.196	0.078	0.064	62.2	10	10	18.75	0.07	56410.80322284
2013-04-28	23:23:28.939	J13	$r_{\rm SDSS}$	0.442	0.104	0.052	0.038	65.0	10	4	18.65	0.15	56410.97960762
2013-04-29	01:27:45.196	W85	rp	0.334	0.157	0.165	0.084	69.2	6	6	18.59	0.15	56411.05844714
2013-04-29	02:13:39.397	W85	rp	0.426	0.234	0.226	0.110	66.3	13	13	18.70	0.19	56411.06567413
2013-04-29	19:23:33.315	K91	rp	0.250	-0.488	0.062	0.074	63.0	10	10	18.76	0.09	56411.80310880
2013-04-29	23:21:34.663	J13	$r_{\rm SDSS}$	0.281	0.244	0.062	0.070	65.1	9	7	18.74	0.07	56411.97699561
2013-04-30	01:26:19.503	W85	rp	0.600	-0.578	0.062	0.082	48.4	10	7	18.76	0.13	56412.05684605
2013-04-30	19:23:11.147	K91	rp	0.623	-0.601	0.092	0.127	64.8	10	10	18.73	0.07	56412.80290586
2013-05-01	23:18:06.636	J13	$r_{\rm SDSS}$	0.578	-0.633	0.062	0.045	61.6	9	7	17.52	0.10	56413.97436861
2013-05-03	01:38:12.086	J13	$r_{\rm SDSS}$	0.784	-0.794	0.075	0.028	66.8	9	9	17.43	0.10	56415.07168361
2013-05-03	22:35:50.998	J13	$r_{\rm SDSS}$	0.320	-1.017	0.032	0.022	83.7	9	9	17.39	0.09	56415.97157561
2013-05-05	23:12:35.712	J13	$r_{\rm SDSS}$	0.698	-1.164	0.074	0.100	72.7	10	5	17.31	0.12	56417.97252561

on April 23, the second on April 30, and a final one on May 7, i.e. after the end of OR3. This delivery added all useful data which was processed after the official end of OR3. All deliveries contained an OPTO file which contains the data and[6] an OPTT file with the telescope data. The first OPTT file only contained the data of those two telescopes whose data was in the OPTO file, all later versions have the full set of 8 telescopes taking part in this exercise. Every OPTO-file included the data from earlier deliveries (only data from OR3). The files passed the format test, there was however a problem and subsequently a delay in incorporating the files into the Main Database. For this however, GBOT is not responsible, since the files corresponded to the format requirements specified in HS-003.

Telecons with representatives from all participating outposts, i.e. GBOT Office in Heidelberg (M. Altmann), GBOT Data Centre in Paris (F. Taris, S. Bouquillon) and the observatories LT (J. Marchant) and LCOGT (T. Lister, T. Brown) were held at the dates indicated in the GBOT-OR3 plan (see Sect. 2), another teleconference was held before the start of GBOT OR3 activities. The daily telecons between the GBOT office in Heidelberg and Data Centre in Paris were mostly not held, lacking the need. Mostly Email exchange was sufficient. For the operational phase this means, that in General daily telecons within GBOT will not be necessary, there should be about two every week - at least in the beginning.

As a further tool of communication between the various components, the GBOT office issued a number of news bulletins (three in the case of OR3) in form of emails summarising the events and issues of the ongoing operations. This seems to have been a proven method to distribute information in a concise way, and should therefore be continued during operations - aiming at one per week, maybe more during the commissioning phase, maybe fewer later, as the need arises. In order to prevent too many emails being circulated, there should be no fixed schedule for these bulletins. The bulletins are presented as sent in Section A.2.

Notes on unscheduled events and recommendations concerning GBOT operations are described in the relevant Sections of this document.

3.2 Data results

Since the main aim of the OR3 went rather smoothly and is also summarised in SE-039, the main focus of this report is the data analysis and consequences out of this for the operational phase. Please note that the contents and outcome of this section is subject to change as the discussion within GBOT develops. Because of the reference catalogue issue, which prevents GBOT from reaching its accuracy goals the astrometric performance is not part of the official OR3. This does, however not prevent GBOT from evaluating and analysing the results. Table 2 shows the astrometric and photometric results. The automatic plots for each sequence, as produced by the GBOT pipeline are presented in Section A.1 (Figs. 15 to21. This section focuses on the dependencies of object brightness and Lunar Phase/Distance to Planck. Other

[6] upon request from MOC

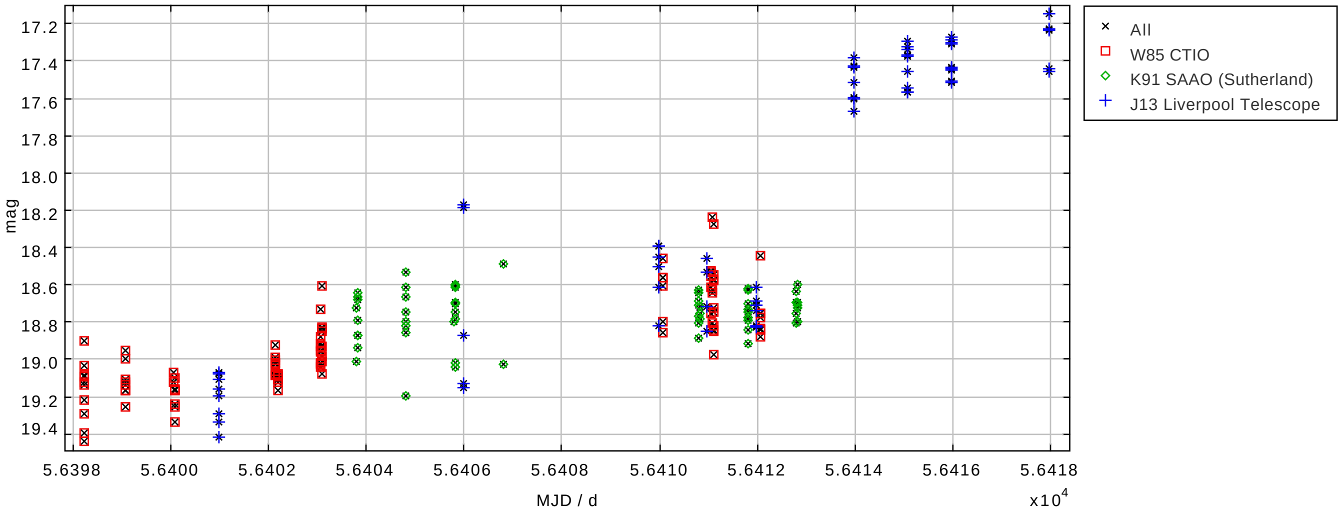

FIGURE 6: Development of Planck's brightness during the OR3. The different symbols denote the datapoints from different telescopes: blue crosses=LT, red squares=CTIO unit W85, green diamonds=SAAO-K91. The gap near MJD 56408 is due to the Full Moon, the official end of OR3 was on MJD 56413.0

factors, like seeing, sky transparency, hour angle, airmass also certainly play a role, but are currently not discussed. This may happen in the future, with the caveat that the number of data points in the dataset may not be sufficient for an analysis with all possible parameters, especially since the data points are not completely independent, as in this case.

The first and at first glance rather unwelcome outcome was the unusual faintness of the OR3 target, the ESA-Planck spacecraft. Instead of its usual magnitude of $R \simeq$18 mag, it was fainter than 19 mag in the first part of OR3 (roughly before the official start of OR3, see Fig. 6), or just above during the second half. The Liverpool telescope delivered data for a few additional nights after the official end[7], and to our surprise the magnitude jumped to $\simeq$ 17.5 mag - i.e. brighter than usual - exactly after the end of OR3 (Fig. 6). The reasons for this are unknown. The magnitudes of Planck are shown in Table 2.

Since GBOT has been working under the assumption that Gaia will have a magnitude of around 18 mag (called nominal in the following), this means that we do not expect the precision of our results to be as good as required. On the other hand this gave us the opportunity to study a "bad-case scenario", i.e. Gaia being significantly fainter than assumed[8] The still open Gaia brightness issue is described in MA-003. On the downside, the fainter signal will increase the duration of the Full Moon gap.

[7]Due to a miscommunication and bad weather (see Sect. 4, the LT joined in a bit later, and we decided to get some more nights of data for the Full Moon study

[8]The "worst case scenario" would be if Gaia is significantly fainter than 20 mag, which would mean that GBOT will not be able to operate.

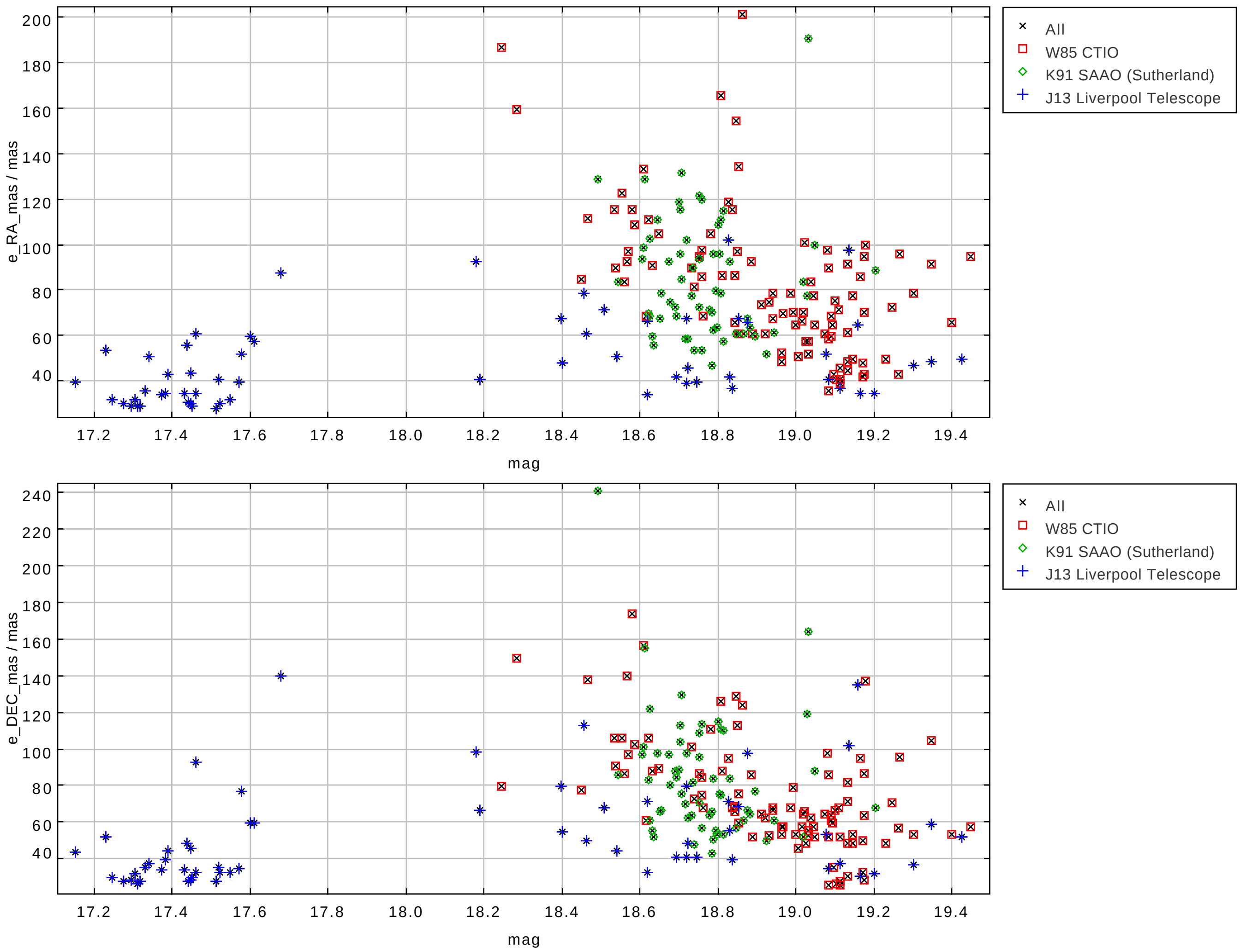

FIGURE 7: Dependency of error on magnitude, upper panel, RA, lower panel Decl.

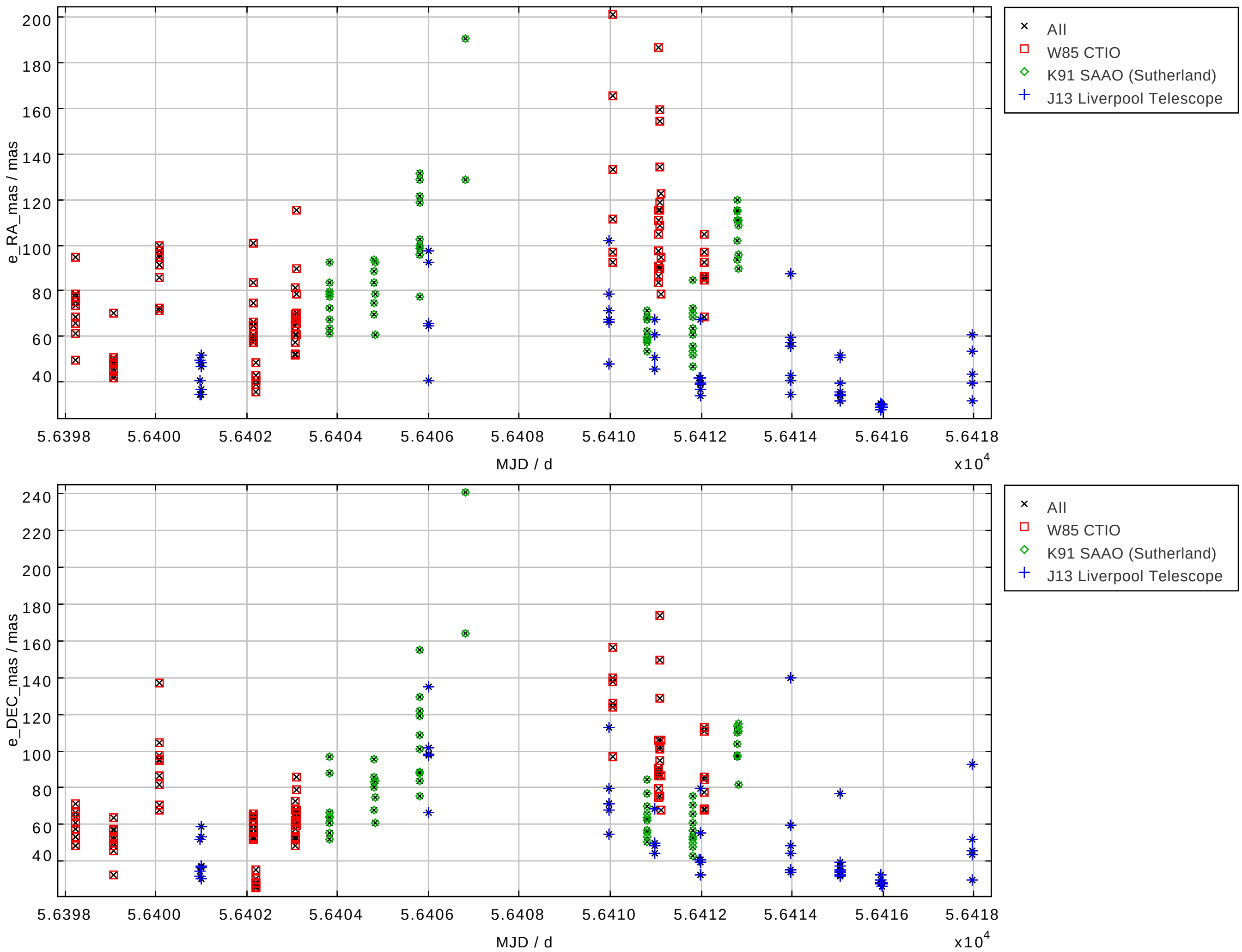

FIGURE 8: Errors plotted against MJD. Note how the error increases towards the Full Moon, which lies approximately at the centre of the gap

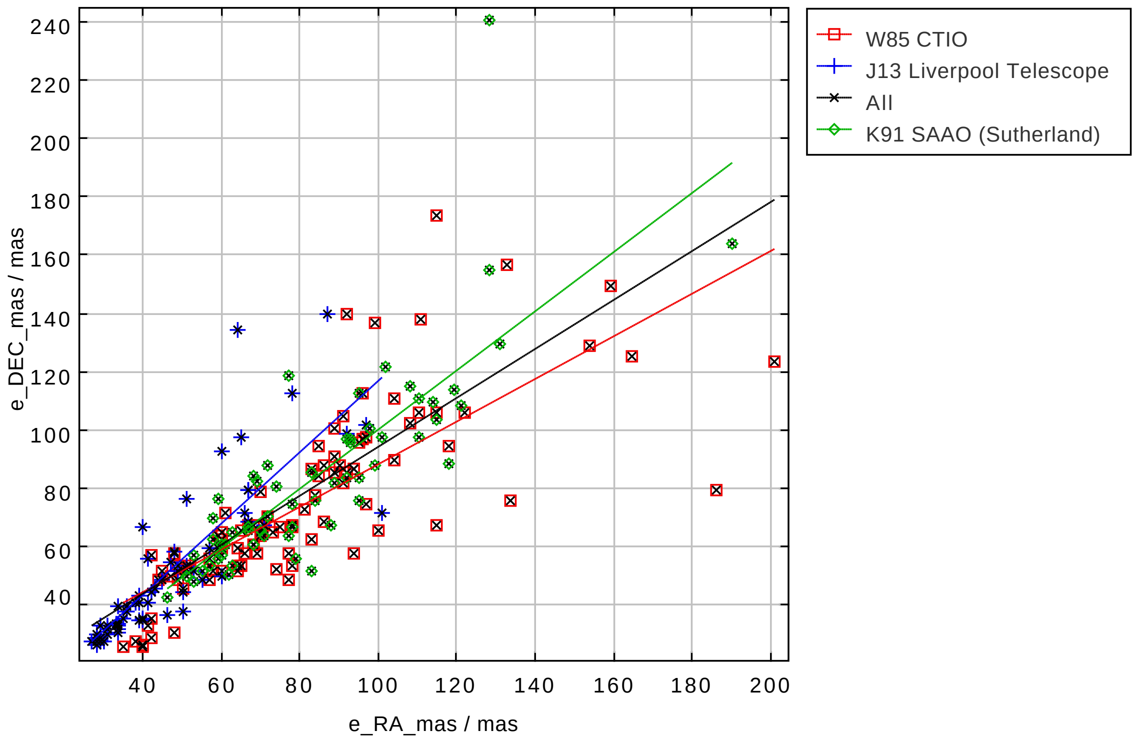

FIGURE 9: Errors vector point plot, also showing the correlations of the errors in RA and DEC for the dataset (black line) and all telescopes separately (colour corresponds to each facility's symbol colour.

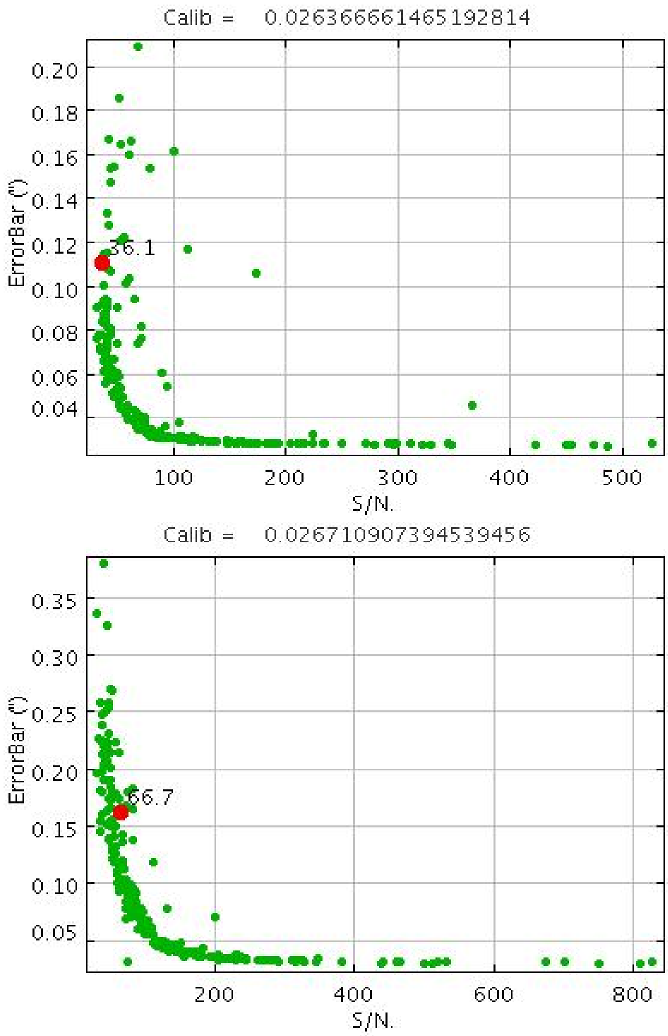

FIGURE 10: Relation of error vs. S/N for all stars in the field of typical individual exposures taken with the CTIO unit W85 of 60 secs (above) and 90 secs (below). Planck is denoted by the larger red dot and the S/N value in the plot. On the figure showing the data from the 90 sec exposure shows the Planck dot moving to the right of the curve, indicating that the error is not entirely depending on the S/N anymore - setting an upper limit for exposure times (which can vary with seeing).

Fig. 7 shows the errors in dependency of the magnitude. Not surprising the best values are for the LT data taken after the OR3, when Planck was at its brightest. The main part of the points, i.e. with Planck at magnitudes of 18.6-19.4 do not show a clear trend. Actually the errors appear to be worse for the brighter part of this datapoint cloud. The reason for this can be found in Fig. 11, namely that this part was observed, when the Lunar Phase and distance Moon-Planck were disadvantageous, i.e. near Full Moon. In this case the two effects (object brightness and sky brightness) more of less cancelled out. The deterioration of the measurements in the vicinity of Full Moon can also be seen in Fig. 8. The low brightness of Gaia, i.e. the low strength of the signal against the noise signal from the increasing sky background, will lead to a larger zone of deteriorated astrometry when compared to the ”nominal situation” (i.e. Planck at 18 mag), in which the object symbol is larger than the one measured during OR3 compared with the unchanged sky signal.

Another test, with the results shown in Fig. 9, was to see whether are significant correlations between the errors in Right Ascension and Declination. This does not really seem to be the case, all linear fits between $\Delta\delta$ and $\Delta\alpha$ show slopes near 45°. The slope for the LT is the most deviant, however it also has the smallest value interval on both quantities. Overall this means that there is no significant dependency between errors in Right Ascension and Declination, caused by whatever reason. Possible causes could be e.g. differential refraction MA-009[9], or software effects (e.g. by undiscovered programming mistakes). That we do not see a correlation between the errors of the two coordinates, is quite relieving especially concerning the latter cause.

In order to further explore the S/N issue, we have scaled the measured S/N-values for each sequence with the magnitude to a S/N which would have been measured, were the target at the nominal magnitude of $R = 18.0$ mag. Beforehand it should be noted, that this exercise is rather rough and does not incorporate other factors, like seeing, sky transparency, etc. Also the observing times of the observations are not homogeneous. For this test we started with the usual flux magnitude equation:

$$\Delta m = -2.5 \log \frac{Flux1}{Flux2} \tag{1}$$

Resolved to Flux, we arrive at:

$$Flux1 = Flux2 \cdot 10^{-0.4\Delta M} \tag{2}$$

$Flux2$ corresponds to the actual magnitude, $Flux1$ to $R = 18.00$ mag.

Assuming that the S/N entirely depends on the Flux and stochastic noise, i.e.

[9]The observations were generally made at similar hour angles for each instrument - so a residual DR or DCR signal could show up

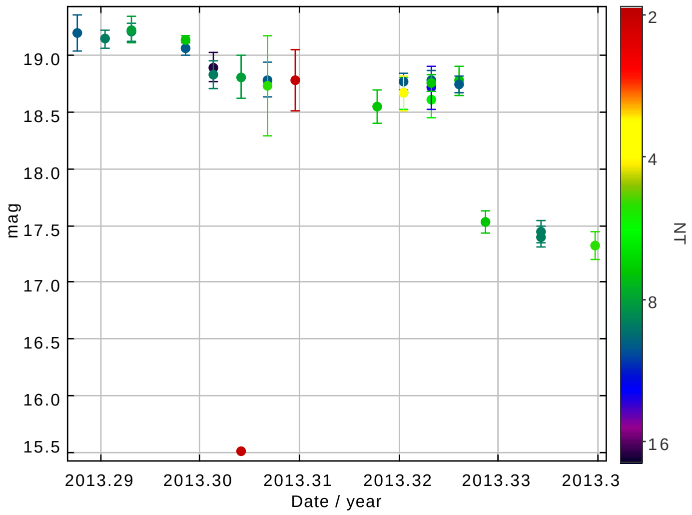

FIGURE 11: Presentation of magnitude data from Table 2 in respect to time (i.e. a sequence-binned version of Fig. 6). The errorbars show the scatter ($\sigma(mag)$) of the measured magnitudes (which are usually caused by short term magnitude variations of the target, ambient variation, e.g. of the sky transparency will only cause a minor effect, since these magnitudes are derived in respect to those of the stars in each field). The number of exposures in each sequence is denoted by the colour of the datapoints. A trend in magnitudes with time and the steep increase near April30/May 1 can clearly be seen. Again, the deviant point at 15.5 is caused by a sequence botched by a very close bright star.

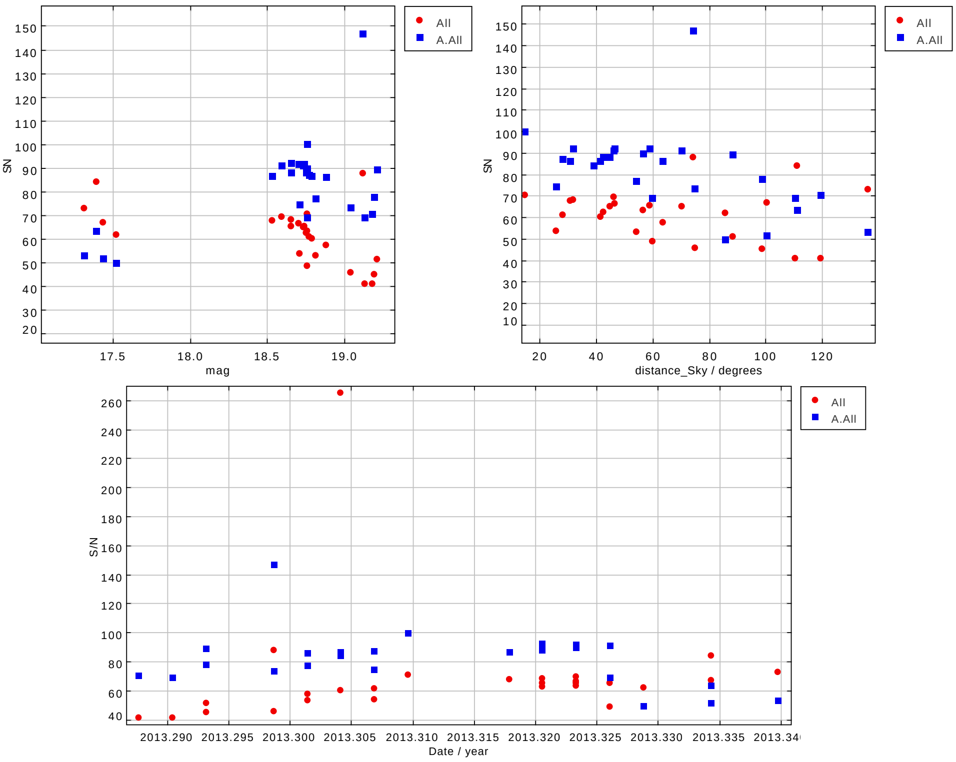

FIGURE 12: S/N of our observations and S/N scaled to $R_{\text{Planck}} = 18.0$ mag. Red symbols denote the actual values, blue symbols the data scaled to 18.0 mag. The upper left plot shows magnitude against S/N, the upper right plot shows the S/N in dependency of the distance between Moon and Planck and the lower one S/N in respect to the date. One striking item is, that the data taken after OR3 when the satellite was at 17.5 mag yield a rather low S/N when scaled to 18 mag. Reasons for this could be bad seeing or bad sky transparency.

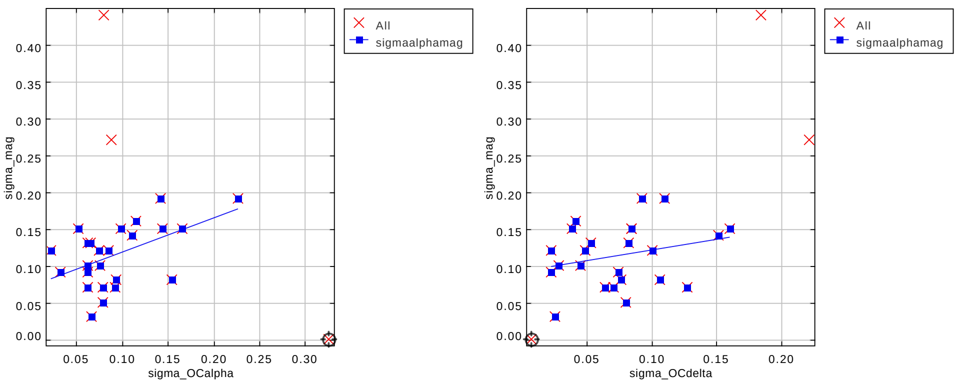

FIGURE 13: Scatter of magnitudes in respect to scatter in $O - C_\alpha$ (left panel) and $O - C_\delta$ (right panel). The red crosses are all data points, the bluer squares show the datapoints used for this analysis. The blue lines show the linear fits

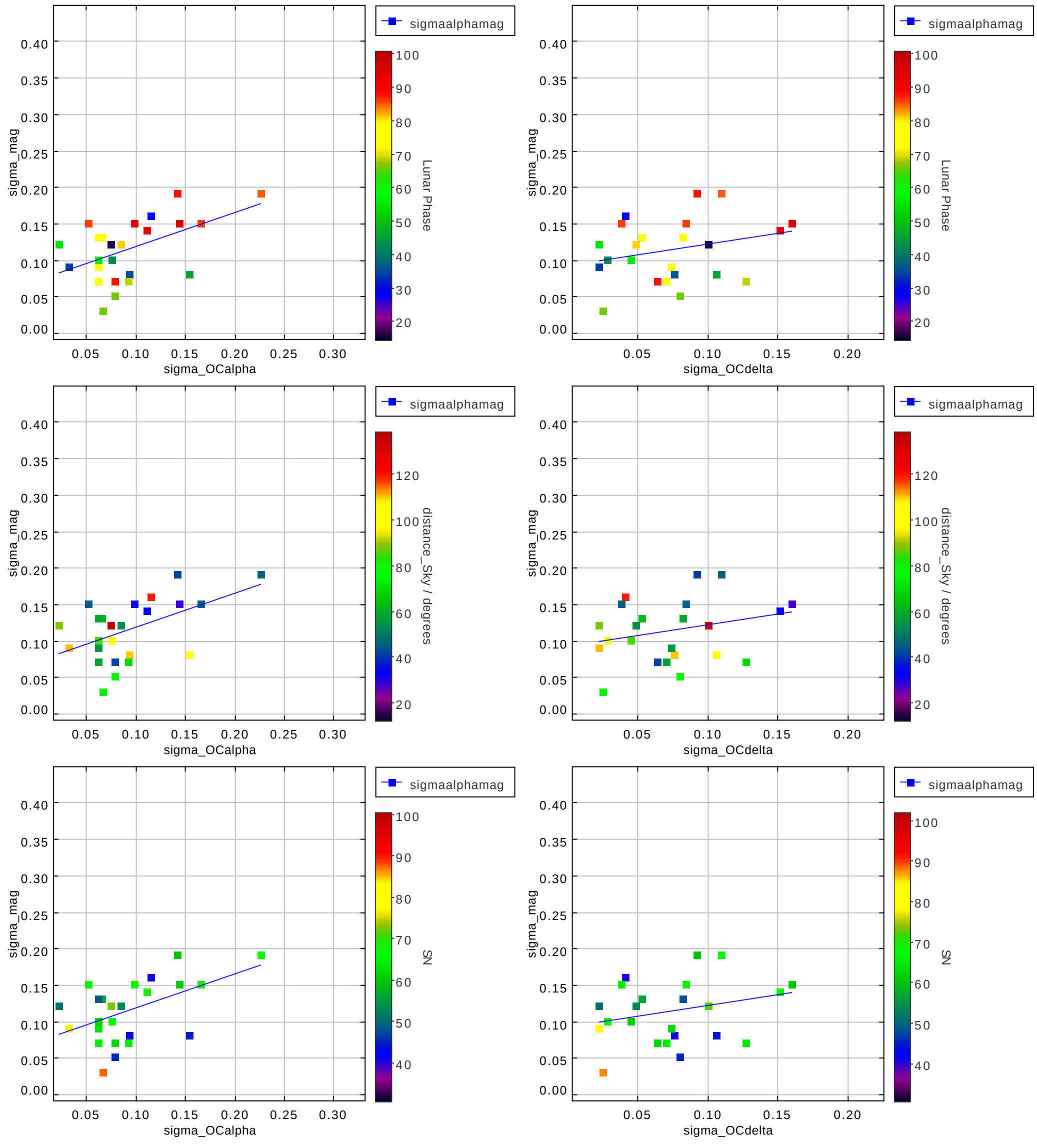

FIGURE 14: Same plot as shown in Fig. 13 (only datapoints) with 3rd parameter colour codings. Again, the left panels show $\sigma(mag)$ vs. $\sigma(O-C)_\alpha$ and the right ones $\sigma(mag)$ vs. $\sigma(O-C)_\delta$. The upper row is coded by Lunar phase, the middle row by distance between Planck and the Moon, and the bottom row by S/N

$$SN = \sqrt{Flux} \tag{3}$$

the scaled S/N would be derived by:

$$SN_{R=18} = \sqrt{Flux1} = \sqrt{Flux2} \cdot \sqrt{10^{-0.4\Delta M}} = \sqrt{Flux2} \cdot SN \tag{4}$$

The according results are shown in Fig 12. In the nominal case, the obtained S/N-values would have been indeed close to the desired value of 100 per exposure. However it must be noted that for the LCOGT units the exposure time used in the OR3 was mostly 60 or even 90 secs. The step to 90 secs (which would increase the nominal S/N of a backgroundless source[10] by 22% in respect to 60 secs exposure time) will probably not bring us a huge benefit, since one has to take the background noise and also the object movement into account, the latter starts manifesting itself in the accuracy, as can be seen in Fig. 10 - the exposure time where this happens also depends on the ambient seeing. However the results show a strong argument for 60 secs (increase of S/N by 41% for a backgroundless source in respect to an exposure of 30 secs).

From the computed errors and the $O - C$ values (calculated as: $\Delta pos_{O-C} = pos_{\text{obs}} - pos_{\text{eph}}$) it is clear, that especially the 1 m telescopes have difficulties coping with an objects of such faintness, even although we increased the exposure time per image from 30 secs via 60 secs to 90 secs. The 2 m LT copes somewhat better (as expected), although we have rather few points from the phase of Planck being at its faintest. Looking at our diagnostic tools, at an exposure time of 90 secs the error begins to deviate from the S/N-error curve, see Fig. 10. Therefore at usual seeing conditions 90 secs is the upper limit for exposure times of individual exposures. This value will be seeing dependent.

The variations in magnitude are in most cases significantly larger than the precision. An additional scatter is caused by different surfaces reflecting light to the observer as the spacecraft moves and rotates. As shown in Fig. 13, there seems to be a trend between the scatter of the magnitude within a sequence and the astrometric scatter. Since many other factors will play a role, this correlation is not particularly strong, the correlation coefficients being 0.51 and 0.26. One reason for this correlation could be a decreasing S/N because of the lunar phase and sky distance. Fig. 14 (upper four panels) indeed hints at a certain dependency of these two quantities, however this is far from clear. Moreover, the S/N itself does not show such a dependency. The spacecraft, Planck, itself should be far too small to cause this effect, even in the extreme case that the centroid of the PSF moves from one edge of Planck to the other. The apparent size in the sky is less than 1.5 mas (which would be the value for the much larger Gaia). A possible culprit that might cause this correlation is the set of reference stars, which loses S/N with an

[10]Due to the sky background in any real image, the gain in S/N will be lower than without, since the sky signal also grows with exposure time. Other sources of noise, such as readout noise do not grow with time.

increase in sky brightness as caused by the approaching and filling Moon, in contrast to Planck in this particular dataset, since Planck brightened as we approached Full Moon. At current this trend between photometric and astrometric scatter, if real, cannot be explained, it is just another indication that we do not yet see the whole picture concerning astrometric scatter.

Additionally we also made a finding this time which has been observed in many GBOT tests, namely that the $O - C$ scatter is in many case non-Gaussian, but seems to follow trends, see Figs. 15 to 21. This might mean, that the $\sigma_{\mathrm{O-C}}$ values so not only reflect the S/N driven precision but also something else. An inspection of the curves in Figs. 15 to 21 show little or no correlation between the variations in light and positional $O - C$ within sequences. Therefore, the findings described in the previous paragraph notwithstanding, a direct relation of small time scale light variations and variations in position seem unlikely. As previously described these would be hard to explain anyway. A possible explanation could be that the magnitudes of the stars used to determine the astrometric solution are close to the magnitude cutoff of the reference catalogue, which means that not only the well known deficiencies in accuracy of the current material are in play, but also precision effects, and solutions depend on individual stars. This needs to be investigated further and would this effect, if present would be eliminated by the use of Gaia data, which is much more precise also in this magnitude range.

Moreover, in many cases there is one extremely deviant point, which spoils the overall precision. Therefore we suggest to increase the number of exposures per sequence from 10 to 12, allowing to dispose of the most outlying points to either side in a minmax type culling[11]. One could also image using other clipping mechanisms. In case of Gaia being fainter than nominal - given the limitations on exposure time per shot - the number of observations should be increased further. However this question only becomes relevant once we really know the magnitude of Gaia (which can even evolve during time). If these measures are taken, and the number of exposures are adapted to Gaia's brightness, we can mitigate fainter than nominal magnitudes of up to about 20 mag in the extreme cases. In this case more of the load will have to be carried by 2 m class telescopes (as expected, nothing new here). Applying the errors found in this non-nominal situation (see above) to the nominal situation of Gaia having a brightness of 18 mag, we will recommend that the 1 m telescopes use an exposure time of 60 instead of 30 secs, see Sect. 5.

4 Unplanned events and their mitigation

While overall the routines during OR3 worked very well, some glitches did occur. This section describes these and gives advice on how to prevent these in the future. Overall the number of such events was rather low, which could be an indicator that the GBOT system generally works quite smoothly.

[11] as used in ski-jumping or ice skating

1. 15./16.4.2013: There was some confusion at the Liverpool telescope, concerning the commencement of observations. This was caused by two causes: first the different starts of OR3 activities by GBOT and the rest of DPAC (i.e. the official start of OR3), on April 15 and 22 respectively, and second the way this was documented in the OR3 GBOT plan (see Fig. 1), which while being clear, does not accommodate for many readers reading such a text in a fast mode (since they have to quickly digest a lot of text). This glitch is highly OR3 specific and unlikely to happen during the operational phase; however it does hold some lectures for the GBOT crew and its collaborators to be learned. To prevent this glitch from happening in the future the most relevant information needs to be spelled out more clearly - i.e. in larger font. A second measure would be alerting the relevant protagonists per email, asking for confirmation that the alerting email has been read and digested.

2. 17./18.4.2013: For the scheduling of observations at the Liverpool telescope an outdated OB was used, using"Flexible" mode instead of "Monitor". This caused observation to be taken on the first night, but not on the second (after that this was noticed, and the error rectified, and everything worked fine after that). While no data were really lost that night (since ambient conditions prevented the taking of useful data anyway), this is something that potentially could happen during the operational phase as well, and therefore a remedy must be put in place. A very simple and useful solution would be to include a sample set of observing parameters/constraints in each observatory ICD document (e.g. MA-010 or MA-012), giving the telescope operator the guidelines he needs.

3. Data delivery to SOC. The data were dumped into the wrong directory at SOC; while it should have gone to `/gbot/from_gbot` it went to `/gbot`. This will be rectified by using the automatic pipeline procedure and/or via "step by step" procedure instruction leaflets (the compilation of which has already begun.

5 Recommendations for the operational phase

While GBOT has been running observational tests for a number of years, an official event such as the OR3 gives a rare opportunity for a more concerted effort. This leads to a number of recommendations *(which will be extended time goes by and the need arises).*, presented in this section:

5.1 Observations

- Exposure times: Recent experience shows that it is desirable to increase the exposure time of the LCOGT 1 m telescopes to 60 secs even in the nominal case of Gaia having a brightness of 18 mag. While 1 m telescopes are able to cope with the 30 secs now in the specifications, moving to 60 secs will be of very large advantage especially during less than optimal weather, and during grey time. For the 2 m telescope(s) this is not as pressing, however, one would gain precision too.

- Number of exposures per sequence: increasing the amount of exposures to 12 in order to allow minmax clipping while still having a sufficient number of exposures for averaging and standard deviation calculation.
- The Full moon gap (FMG) will be larger for the 1 m telescopes (also expected) - The exact duration of the FMG will be determined based on the OR3 data. It will be in the order of 5 nights centred on the FM night.

These additions would result in 7 min more net time demand (+2× readout), something which can surely be managed. Details need to be worked out.

5.2 GBOT Operations

1. The main parts of GBOT during operations should receive labels/names. The suggestion is that the site in Paris, where the database is located and usually all operations take place physically is called "GBOT data centre", the location of the GBOT coordinator and secondary GBOT infrastructure should be called "GBOT office"
2. GBOT specific accounts should be created in Paris (partly already in place) and Heidelberg. Issues concerning security need to be addressed.
3. GBOT coordinator's office needs white board and world map.
4. The ICD documents for the observatories need to be amended by adding the scheduler parameters, or a typical observing block. This will prevent failures to observe (see Sect. 4).
5. Time zones (this issue was raised by Tim Lister, and I think it is of high relevance, and should be addressed properly): GBOT and the participating protagonists are located in vastly different time zones, some like LCOGT themselves have to deal with telescopes located in different time zones. For this reason a unified reference to times must be defined and followed. The suggestion is to follow the usual practise, i.e. to use UTC (GMT, Zulu-time, UT) for all official times in the world of GBOT. In the following we give guidelines of how to refer to times in different situations for issuers of times and guidelines to interpret or how to react for recipients:
   - Issuers:
     (a) All times need to be in UTC! This especially applies to all matters concerning telescope activities, starts or ends of observing periods, etc. Dates should be given in UTC date. For analysing results, etc., MJD would be the relevant day counting system.

   (b) In some cases, e.g. announcements of telecons, etc., only UTC may not be the best solution. In such cases the following rule applies: 1. UTC, then the other times, identified by their usual code (i.e. CET, CEST, MDT, etc.)
   (c) All times given need to be identified with their timezone code, even UTC! Giving a time without TZ-ID is deprecated!

- Recipients:
   (a) Make sure, that the time you have been given has a timezone identifier!
   (b) If not, ask the issuing agent
   (c) If issuing agent is not available and the action connected to this timestamp is pressing, assume UTC. Act accordingly but give feedback to issuing agent when available.

This seems to be a bit overstated, but one has to account for human sloppiness, therefore such rules are justified.

6. For the GBOT operations (data reduction, data delivery to SOC) simple procedure charts need to be set up. First versions of these have been constructed in the meantime.

7. T. Lister has found and measured a number of minor planets/SSO's on data taken with the LCOGT telescopes (Lister et al., 2013). While this is not important for GBOT itself, it may be for other parts of DPAC, i.e. GaiaFUN-SSO; Therefore it would be a nice spin off, if the data taken for GBOT would be routinely inspected for such objects. In preparation for this, this idea could be conveyed to the GaiaFUN-SSO team.

A Appendix

A.1 Data plots

Here the data plots as produced by the GBOT pipeline are represented. On the left side, the astrometric $O - C$ plots are given, on the right side the magnitude plots. The results for W85 are shown in Figs. 15 and 16, those for K91 in Figs. 17 and 18, and finally the Liverpool telescope results in Figs. 19 to 21

A.2 News bulletins

The following contains verbatim copies of the news bulletins issued to the GBOT group and observatories during OR3. These were used to inform all participants and to maintain an uniform level of information on the progress of the rehearsal. Originally they were sent by email.

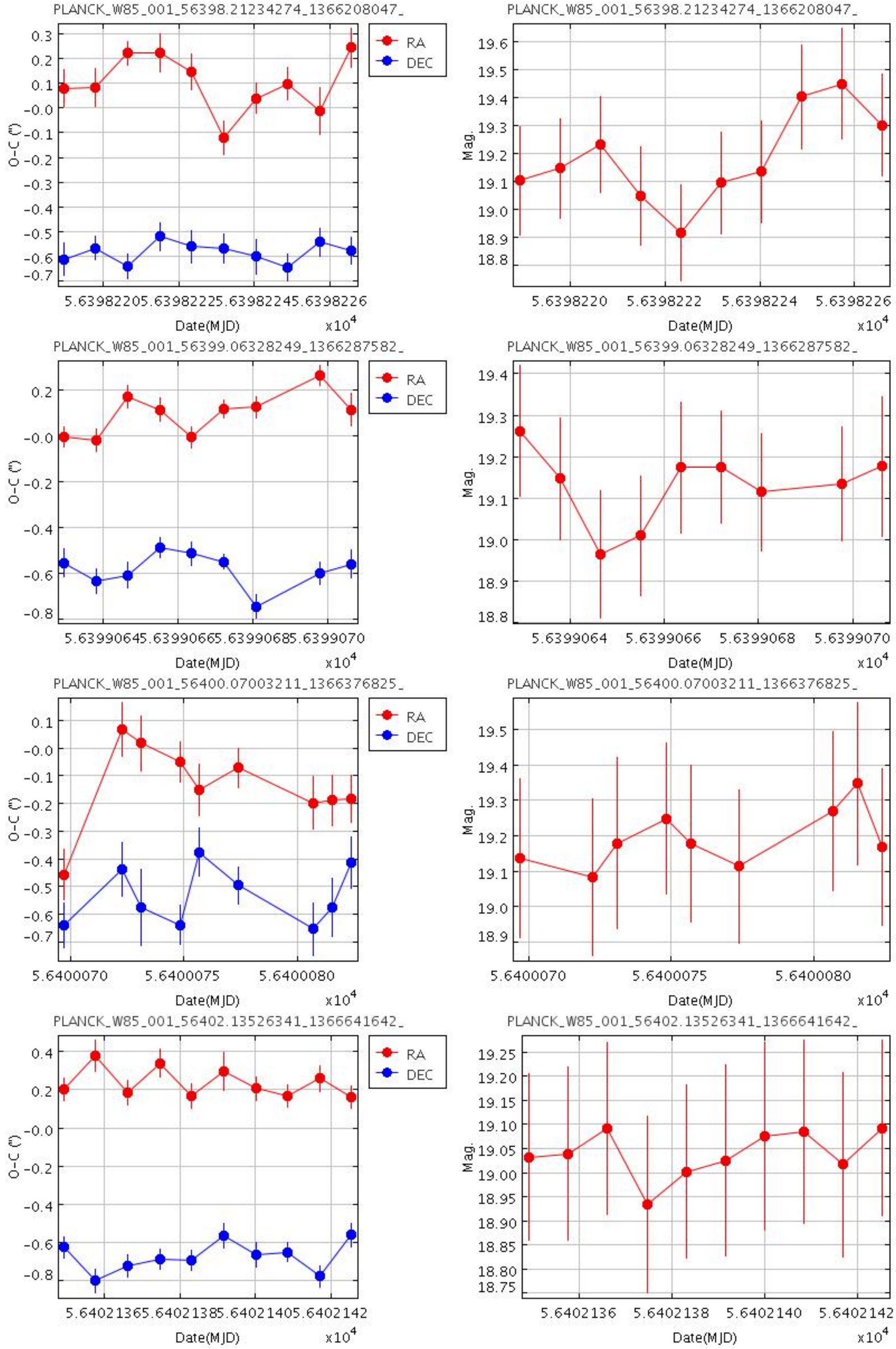

FIGURE 15: $O - C$ and magnitude plots of the observations of the W85 unit of LCOGT located at CTIO

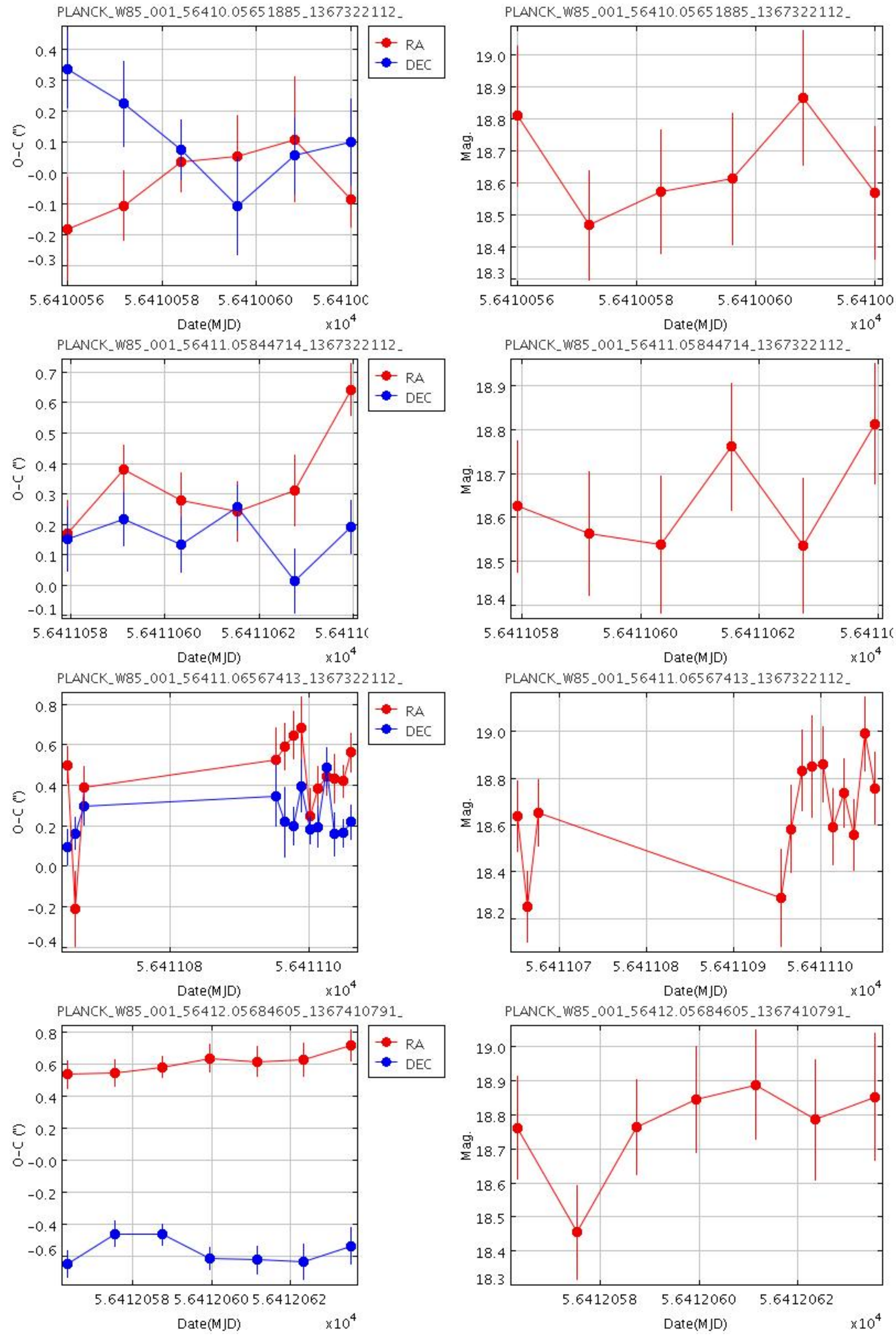

FIGURE 16: $O - C$ and magnitude plots of the observations of the W85 unit of LCOGT located at CTIO

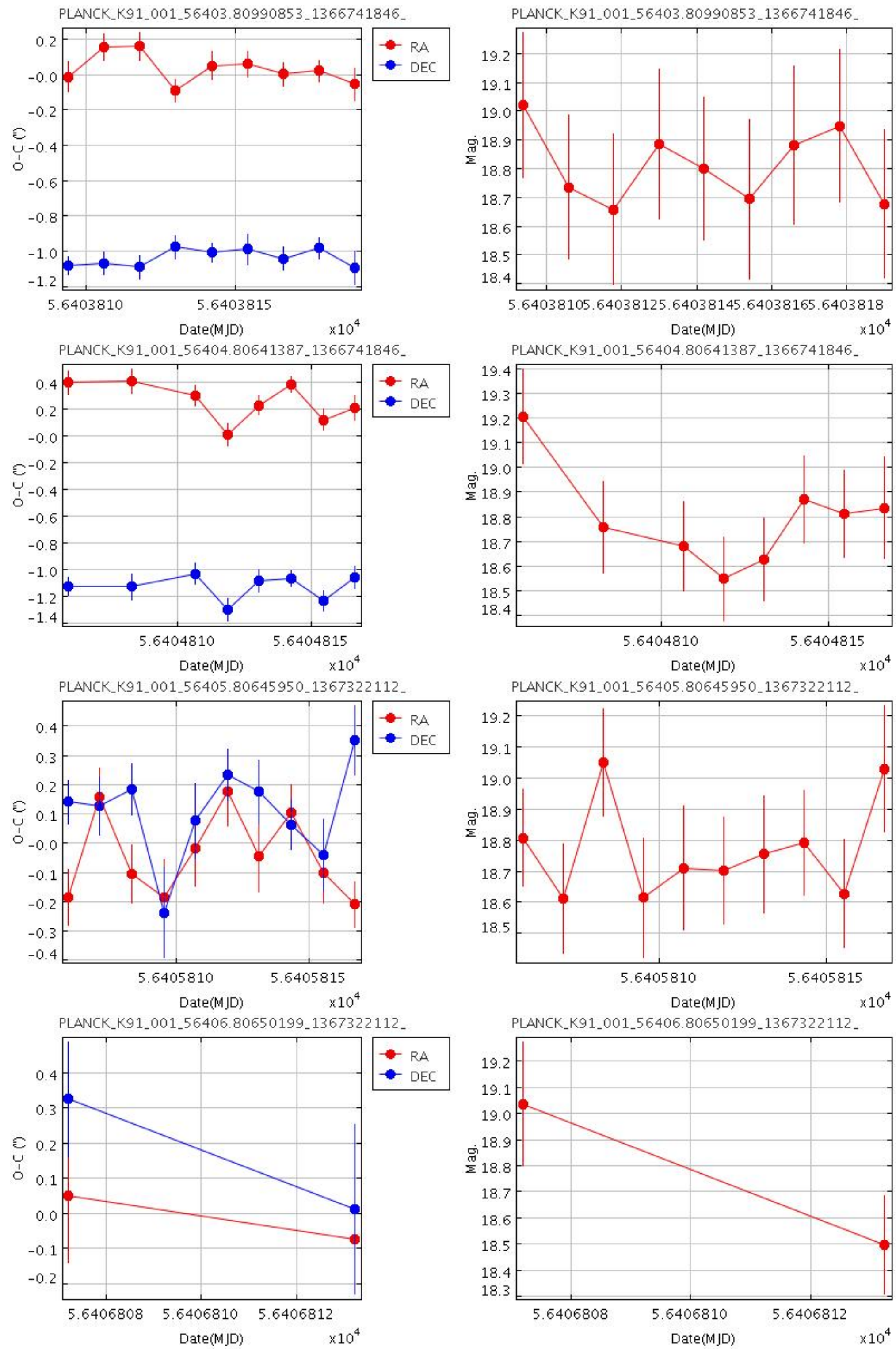

FIGURE 17: $O-C$ and magnitude plots of the observations of the K91 unit of LCOGT located at SAAO

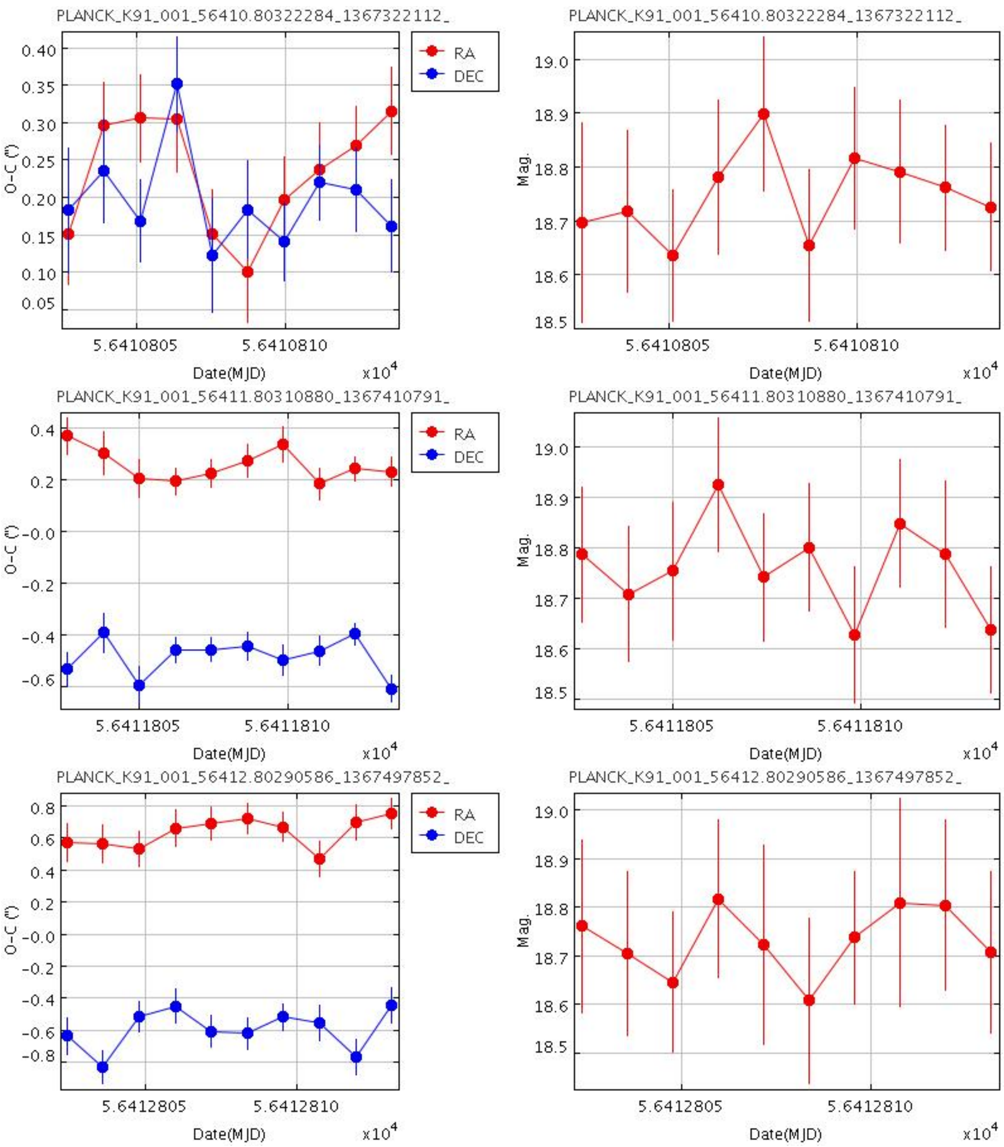

FIGURE 18: $O-C$ and magnitude plots of the observations of the K91 unit of LCOGT located at SAAO

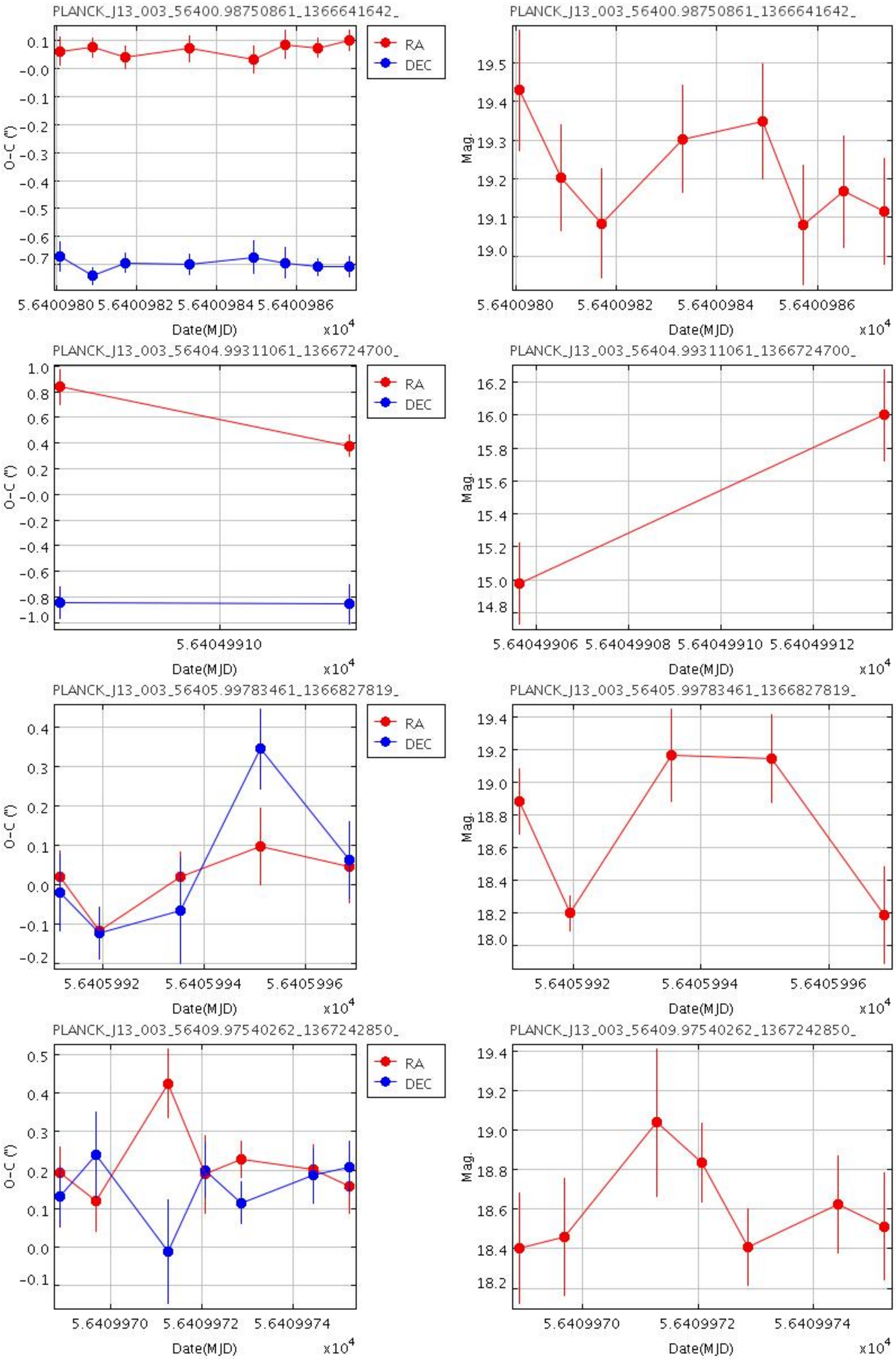

FIGURE 19: $O - C$ and magnitude plots of the observations of the Liverpool telescope (MPC code J13) located at Roque de los Muchachos (La Palma)

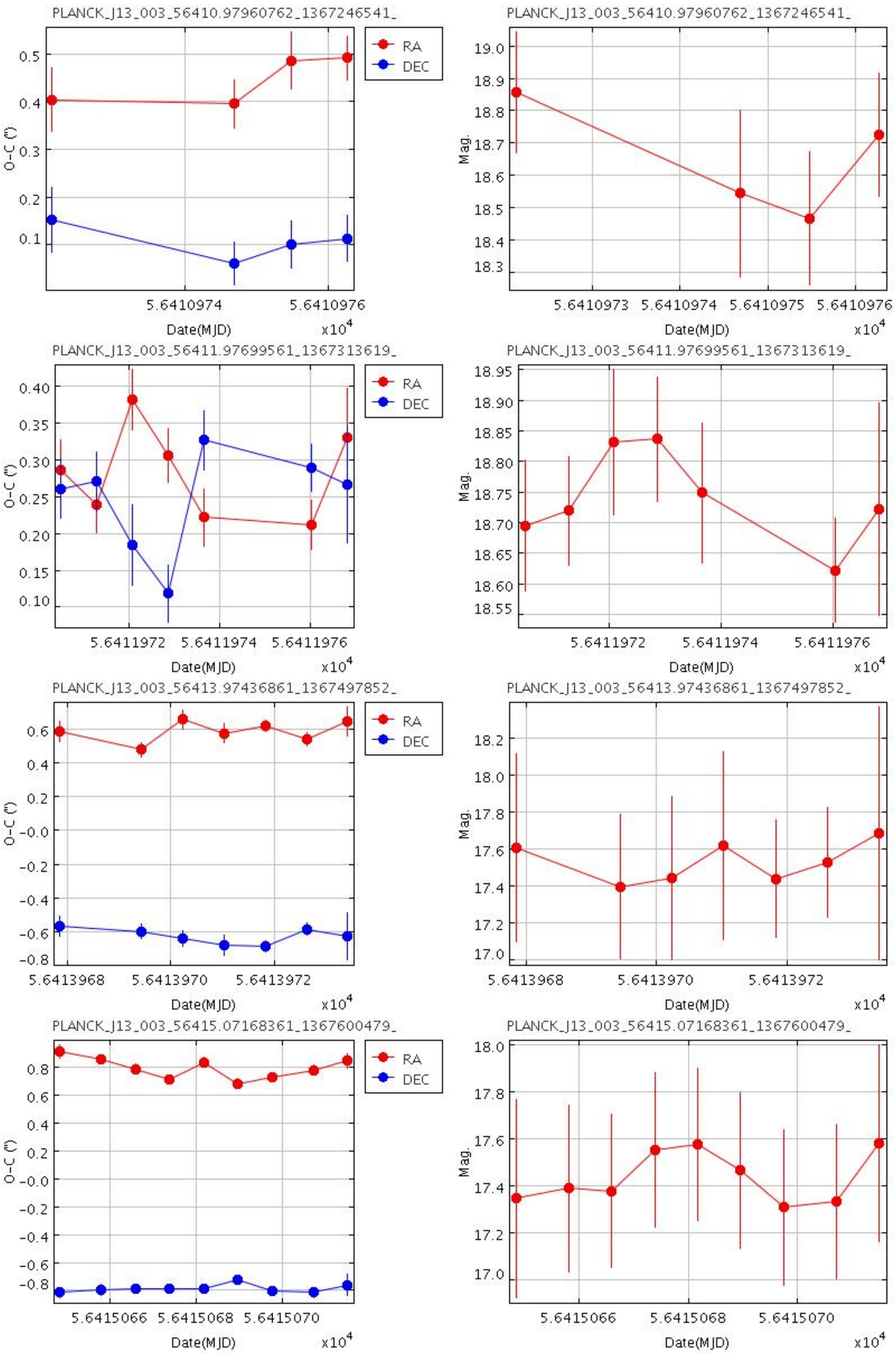

FIGURE 20: $O-C$ and magnitude plots of the observations of the Liverpool telescope (MPC code J13) located at Roque de los Muchachos (La Palma)

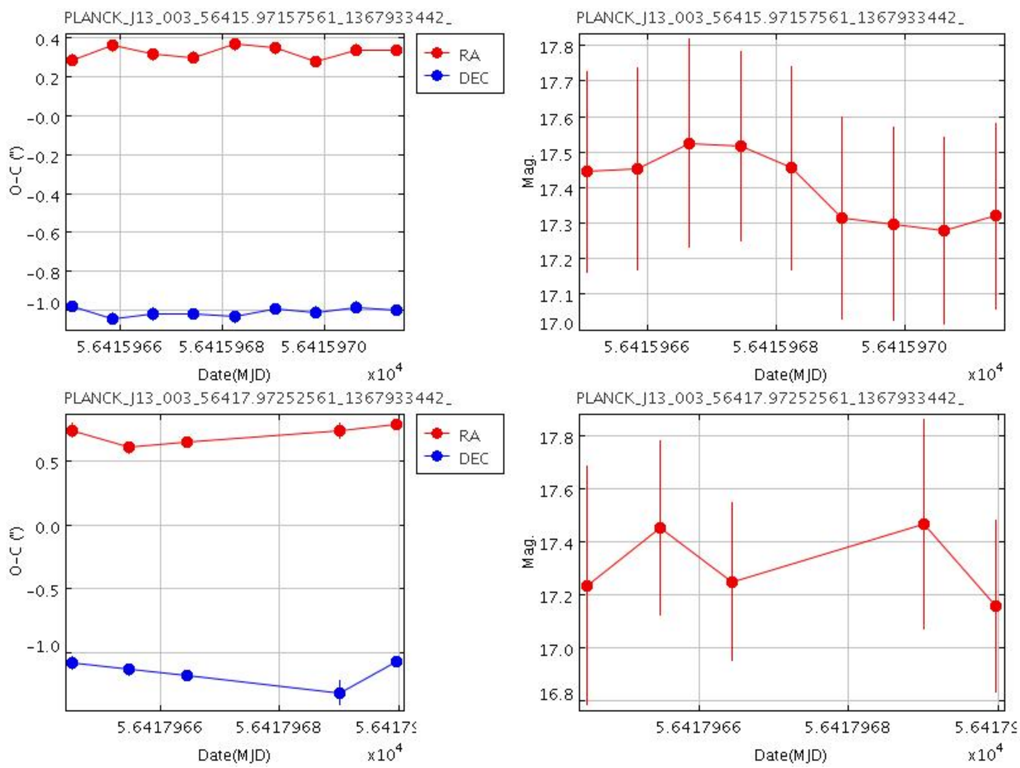

FIGURE 21: $O - C$ and magnitude plots of the observations of the Liverpool telescope (MPC code J13) located at Roque de los Muchachos (La Palma)

A.2.1 News bulletin No. 1, Thursday, 18.4.2013

GBOT has initiated it's operations for the Gaia DPAC OR3 on noon (UTC), Monday, April 15, 2013. This is one week ahead of the bulk of OR3 activities - the reason is the full moon on April 25. Now, after 3 days of operations this first news bulletin is issued (inofficial, GBOT only):

Right now, we have two sets of data in our database, both from the W85-unit on CTIO, the first from April 16, the second one from April 17. The other two sites of LCOGT were mostly clouded out, and did not deliver useful data. Liverpool started a day late, because of a bit of miscommunication (the reason of which has since been addressed and is considered to be minor). Unfortunately the weather has not been good since then, so at present we have no data from LT.

Another rather unpleasant surprise is the brightness of our target, namely Planck which is significantly fainter than expected or than it has ever been. Instead of the usual 18 mag, it is now about 19.2 mag faint (all in R). Therefore the r.m.s. errors will be larger than usual. For the case of LCOGT we have raised the exposure time to 60 secs per shot. LT will continue to operate at the nominal exposure time. However these data allow us to firmly determine the demand of exposure time and number of exposures should Gaia be fainter than our nominally assumed magnitude of R=18 mag.

Database and pipeline have been working without glitches, the delivery from observatory to GBOT is going smoothly, the delivery of data from GBOT to SOC has not been done, since the official OR3 is only starting next Monday, and the first date of delivery is Tuesday, April 23. Therefore one can say, that since the main aim of this OR (in the context of GBOT not at large) is to test operations and communications between GBOT, SOC, and 2 observatories is going well so far.

Apart from these nominal aspects, we have been getting quite some input which can be used for the operational planning, mistake-mitigation, limits of operation.

For the upcoming weekend, we'll continue operations as now, during the weekend the amount of feedback from GBOT will be limited. Both observatories will continue working as before (hopefully with better weather in some of the sites). The next regular bulletin will be issued on Tuesday, after delviery of the first dataset to SOC.

One last item: Because of a day long strike of public transportation in the Heidelberg area, my availability may be compromised. However if all goes accodring to my plans to circumvent this go well, I should be in office, maybe a bit shorter than usual.

To conclude, I would like to thank all people participating in the GBOT part of this rehearsal, keep up the good work. Weather and Planck's performance is beyond our reach. So, while the general outcome is a rather mixed bag of beans, overall I am quite satisfied. To all a great weekend.

PS.: For access to the Heidelberg mirror, a reminder to send the necessary IP-address information. So far we have received none.

Martin Altmann (GBOT-coordinator)

A.2.2 News bulletin No. 2, Tuesday, 23.4.2013

Following a short conversation between me and the operations centre in Paris, they are preparing the first data delivery as I write these lines.

We have received data over the weekend from LCOGT's unit W85 at CTIO, the McDonalds and the Liverpool. Unfortunately the weather was not too good in other places, and the seeing in McDonald was with 4" and 5" too high. For one night the LT-facility was shut down because of Calima conditions (Calima = dust wind from the Sahara). Last night's series from LT was hampered by the presence of a very bright star very close to the object. As some of you know, the GBOT group is putting some thought into minimising these events, but for now this is just tough luck. The Planck satellite itself remains at it's extreme faintness, it may even be slowly getting fainter (my hunch from looking at the magplots, not a real analysis). Nonetheless these data will help us in deterining the faint limit that GBOT can handle, so it is actually more usefull, than if Planck would have been constant at the nominal magnitude of 18.

We are now approaching the full moon window (actually the contrary to a window, is there a word for this? :-)). I would like to ask the observatories to continue to observe, to the point where the data becomes too bad. This will help us immensely with the operational planning. Full moon will be on April 25, 19:37 UTC. After the full moon we will restart with observation symmetrically.

Then I would like to remind you of tomorrows telecon, during which we will review the overall progress, etc. see my mail from earlier today.

To conclude, I would like to thank everybody again, keep up the good work. Weather and Planck's performance is beyond our reach. So, while the general outcome is a rather mixed bag of beans, the operational thing seem to work quite well.

PS.: For access to the Heidelberg mirror, a reminder to send the necessary IP-address information. So far we have received none.

Martin Altmann (GBOT-coordinator)

A.2.3 News bulletin No. 3, Tuesday, 30.4.2013

This is the final news bulletin for this OR3, which from the GBOT point of view went very well. Looking beyond our little GBOT world, I only have limited information, but it seems that on the whole things went better than expected. Presumably there will be another OR, OR4, however it seems likely that this will not involve GBOT, since we have demonstrated that the system works. Everything else is in the details. Please note, that while it is likely that GBOT doesn't need to participate in OR4, this is not sure at this point, I will keep you informed about any developments in this matter.

Today, we have delivered the second OPTO/OPTT file, at current I do not know whether the first one has been ingested into the system in the meantime (yesterday it wasn't). There will be a 3rd installment containing the data not included in the 2nd one - however due to vacations of some key people, this will not be done early next week but a little later.

We have 20 data sets in the Database, 9 from W85 (LC-CTIO), 6 from the LT and 5 from K91 (South Africa). So the inofficial winner of the "Telescope with the most data" contest is W85 (you may lubricate its gears with some nice Pisco :-)). The Satellite continues to be too faint, it did however get a bit brighter towards the end, reaching a mean of 18.7. This is still significantly fainter than our experience over the years, when for most of the time it was close to 18, sometimes even slightly brighter, very seldom reaching 18.5 as a very extreme value (this object is highly variable on short timescales, but this longer trend seems to be new for me).

In the immediate future we will take a close look at the data in order to make recommendations for various scenarios. These aspects will be topic at the forthcoming GBOT #6 meeting in 2 weeks.

Finally I would like to thank everybody involved in this exercise, be it on the observatories, the Paris data centre or anybody else. You did a great job!

Best Regards, Martin Altmann

PS.: For access to the Heidelberg mirror, a reminder to send the necessary IP-address information. So far we have received none.

Martin Altmann (GBOT-coordinator)

B References

[MA-003], Altmann, A., 2011, *Ground Based Optical Tracking of Gaia*,
`GAIA-C3-TN-ARI-MA-003`,

URL http://www.rssd.esa.int/cs/livelink/open/3094163

[MA-009], Altmann, M., Bouquillon, S., Taris, F., et al., 2012, *Assessment of the influence of sources of error on the total error budget of GBOT observations*,
GAIA-C3-TN-ARI-MA-009,
URL http://www.rssd.esa.int/cs/livelink/open/3148859

[MA-012], Altmann, M., Brown, T., Lister, T., et al., 2013, *Requirements and procedures for GBOT partner observatories -Las Cumbres Optical Global Telescope Network (LCOGT)*,
GAIA-C3-TN-ARI-MA-012,
URL http://www.rssd.esa.int/cs/livelink/open/3164534

[MA-010], Altmann, M., Steele, I., et al., 2013, *Requirements and procedures for GBOT partner observatories - Liverpool Telescope (LT)*,
GAIA-C3-TN-ARI-MA-010,
URL http://www.rssd.esa.int/cs/livelink/open/3164534

[SE-039], Els, S., 2013, *OR#3 Closeout Report*,
GAIA-PO-TN-ESAC-SE-039,
URL http://www.rssd.esa.int/cs/livelink/open/3213902

Lister, T., Christensen, E.J., Larson, S.M., et al., 2013, Minor Planet Circulars, 83517, 2, ADS Link

[HS-003], Siddiqui, H., 2012, *Gaia mission scheduling and optical observation ICD*,
GAIA-C1-SP-ESAC-HS-003,
URL http://www.rssd.esa.int/cs/livelink/open/2954990

B.1 Definitions

B.2 Acronyms

The following is a complete list of acronyms used in this document. The following table has been generated from the on-line Gaia acronym list:

Acronym	Description
AGIS	Astrometric Global Iterative Solution
AO	Announcement of Opportunity
AS	Adjacent Sample
ATP	Automatic Test Procedure
AUT	AUTomated

CCB	Configuration Control Board
CDR	Critical Design Review
CIL	Critical Items List
CM	Calibration Model
CNES	Centre National d'Etudes Spatiales (France)
CPU	Central Processing Unit
CSV	Comma-Separated Value (database output format, e.g., for MS Excel)
CU	Coordination Unit (in DPAC)
DDP	Delivered Duty Paid
DOC	Department of Commerce (USA)
DPAC	Data Processing and Analysis Consortium
DPC	Data Processing Centre
DPCE	Data Processing Centre ESAC
DU	Development Unit (in DPAC)
ECSS	European Cooperation for Space Standardisation
ESA	European Space Agency
ESAC	European Space Astronomy Centre (VilSpa)
FL	First Look
FLOP	FLoating-point OPeration
FTE	Full-Time Equivalent
GAIA	Global Astrometric Interferometer for Astrophysics (obsolete; now spelled as Gaia)
GWP	Gaia Work Package
HW	Hardware (also denoted H/W)
ICD	Interface Control Document
ID	Identifier (Identification)
IDT	Initial Data Treatment (Image Dissector Tube in Hipparcos scope)
ISO	International Organisation for Standardisation (Geneva, Switzerland)
JD	Julian Date
JDK	Java Development Kit
LaTeX	(Leslie) Lamport TeX (document markup language and document preparation system)
MAN	MANual
MDB	Main DataBase
OF	Object Feature (source packet)
PA	Product Assurance
PAP	Product Assurance Plan
PDR	Preliminary Design Review
PR	Progress Report
QA	Quality Assurance
RAM	Random Access Memory

SADT	Structured (System) Analysis and Design Technique
SCMP	Software Configuration Management Plan
SDD	Software Design Document
SDP	Supplementary Data Pattern
SP	SPecification
SPR	Software Problem Report
SRR	System Requirements Review
SRS	Software Requirements Specification
SSS	System Software Specification
STP	Software Test Plan
STR	Software Test Report
STS	Software Testing Specification
SUM	Software User Manual
SVN	SubVersioN
SW	Software
TRB	Test Review Board
TRR	Test Readiness Review
UML	Unified Modeling Language
URL	Uniform Resource Locator
WBS	Work Breakdown Structure
WP	Work Package