System Biases Session A: Analytic Results

C. Luceri, H. Mueller, T. Otsubo

- How do we estimate our system biases in our processing and analysis systems?

- What examples of biases have been seen from the Q/C and final processing systems?

- What are the likely sources of biases? What are the big issues?

FIRST question

How do we estimate our system biases in our processing and analysis systems?

Within ILRS there are basically 2 types of approaches to estimate system biases:

- Fast delivery Quality Check: pass by pass estimation of range and time bias available for some satellites and at different delivery frequencies depending on the AC

- Short/medium/long term estimation: weekly, monthly, yearly biases typically estimated in multiyear solutions by some ILRS Analysis Centers, mostly for Lageos

Fast delivery Quality Check

- Deutsches Geodätisches Forschungsinstitut (DGFI)
  Germany
- Hitotsubashi University
  Japan
- Joint Center for Earth System Technology/GSFC (JCET/GSFC)
  Greenbelt, Maryland, USA
- Russian Mission Control Centre, (MCC)
  Moscow, Russia
- SHAO - Shanghai Atronomical Observatory□CAS
  China

DGFI Q/C Procedure

- Q/C is part of the processing chain for the daily/weekly ILRS products and is used for data editing
- Q/C runs twice a day 08:00 and 13:00 h UTC
- Pass by pass bias analysis for all stations, including quarantine stations
- We are processing Lageos1 and Lageos2
- Results are published on DGFI-Webpage
  http://www.ilrs.dgfi.quality
- Plans are to process other satellites as well
- For new stations a coordinate update will be processed if required

QC Analysis & Report @ HIT-U

Product: **Pass-by-pass range bias & time bias.**

History: **1998-present (CRL → NICT → HIT-U).**

Frequency: **Currently updated every 6 hrs. Latency 2.5-8.5 hrs.**

Software: **c5++.**

Availability: **web (geo.science.hit-u.ac.jp), SLReport, CDDIS ftp, etc. Problems reported via Email (RapidServiceMail).**

Stations: **operational & under quarantine.**

Satellites: **LAGEOS-1, 2, AJISAI, ETALON-1, 2, LARES, STARLETTE, STELLA, JASON-2, SARAL, CRYOSAT-2, BEACON-C, GPS, GLONASS, GALILEO.**

Recent upgrade: **Automatic anomaly notification (done).**

Plan: **SLRF2008 → ITRF2014. Discontinuity expected. Adding more satellites**

HITOTSUBASHI UNIVERSITY

[v2] Multi-satellite bias a

geo.science.hit-u.ac.jp/slr/bias

メール カレンダー

Geoscience Hitotsubashi

Multi-Satellite Bias Analysis Report v2

for Worldwide Satellite Laser Ranging Stations

being updated every 6 hours!

Latest Analysis Report: >> from 12h UTC, 12 Oct 2015 to 12h UTC, 26 Oct 2015 (updated 1421 UTC, 26 Oct 2015)

Stations with high productivity

sat	orbit fit WRMS in mm	# pass/# NP	1st site(ID) # pass/# NP	2nd site(ID) # pass/# NP	3rd site(ID) # pass/# NP
Lageos-1	11	273 / 2317	Changchun (7237) 47/206	Yarragadee (7090) 46/538	Washington (7105) 34/361
Lageos-2	13	260 / 2409	Changchun (7237) 37/189	Yarragadee (7090) 35/392	Washington (7105) 29/443
Etalon-1	13	49 / 197	Changchun (7237) 9/21	Yarragadee (7090) 8/53	Shanghai (7821) 6/18
Etalon-2	16	41 / 189	Yarragadee (7090) 12/75	Changchun (7237) 10/28	Shanghai (7821) 5/20
Ajisai	22	433 / 5541	Yarragadee (7090) 65/1143	Changchun (7237) 63/392	Washington (7105) 48/860
Lares	16	219 / 2455	Changchun (7237) 45/312	Washington (7105) 38/569	Yarragadee (7090) 38/559
Starlette	22	324 / 2962	Yarragadee (7090) 69/801	Changchun (7237) 53/304	Washington (7105) 44/547
Stella	22	176 / 1343	Yarragadee (7090) 37/403	Changchun (7237) 29/128	Washington (7105) 22/228

and more satellites (GNSS and LEO) are included in the reports!!

Archive: (each covers 14 days from the date) 2014 2013 2012 v1: Year 2011 2010 2009 2008 2007 2006 2005

Oct 2015	Sep 2015	Aug 2015	Jul 2015	Jun 2015	May 2015	Apr 2015	Mar 2015	Feb 2015	Jan 2015
12 (00 06 12)	30 (00 06 12 18)	31 (00 06 12 18)	31 (00 06 12 18)	30 (00 06 12 18)	31 (00 06 12 18)	30 (00 06 12 18)	31 (00 06 12 18)	28 (00 06 12 18)	31 (00 06 12 18)
11 (00 06 12 18)	29 (00 06 12 18)	30 (00 06 12 18)	30 (00 06 12 18)	29 (00 06 12 18)	30 (00 06 12 18)	29 (00 06 12 18)	30 (00 06 12 18)	27 (00 06 12 18)	30 (00 06 12 18)
10 (00 06 12 18)	28 (00 06 12 18)	29 (00 06 12 18)	29 (00 06 12 18)	28 (00 06 12 18)	29 (00 06 12 18)	28 (00 06 12 18)	29 (00 06 12 18)	26 (00 06 12 18)	29 (00 06 12 18)
09 (00 06 12 18)	27 (00 06 12 18)	28 (00 06 12 18)	28 (00 06 12 18)	27 (00 06 12 18)	28 (00 06 12 18)	27 (00 06 12 18)	28 (00 06 12 18)	25 (00 06 12 18)	28 (00 06 12 18)
08 (00 06 12 18)	26 (00 06 12 18)	27 (00 06 12 18)	27 (00 06 12 18)	26 (00 06 12 18)	27 (00 06 12 18)	26 (00 06 12 18)	27 (00 06 12 18)	24 (00 06 12 18)	27 (00 06 12 18)
07 (00 06 12 18)	25 (00 06 12 18)	26 (00 06 12 18)	26 (00 06 12 18)	25 (00 06 12 18)	26 (00 06 12 18)	25 (00 06 12 18)	26 (00 06 12 18)	23 (00 06 12 18)	26 (00 06 12 18)
06 (00 06 12 18)	24 (00 06 12 18)	25 (00 06 12 18)	25 (00 06 12 18)	24 (00 06 12 18)	25 (00 06 12 18)	24 (00 06 12 18)	25 (00 06 12 18)	22 (00 06 12 18)	25 (00 06 12 18)

QC Analysis & Reports @ JCET

Product: **Pass-by-pass range & time bias from 7-day arc.**

History: **2007-present (JCET→ GEST→ JCET).**

Frequency: **Currently updated every day - Latency 2 days.**

Software: **GEODYN II (FORTRAN)**

Availability:

http://ilrs.gsfc.nasa.gov/network/system_performance/global_report_cards/monthly/perf_201509_wLLR.html

CDDIS ftp

Problems reported via email (*RapidServiceMail*).

Stations: **operational & under quarantine.**

Satellites: **LAGEOS-1, 2, ETALON-1, 2, LARES, AJISAI, STARLETTE.**

Upcoming upgrade: **Series visualization accessible by users**

Planned: **SLRF2008 → ITRF2014. (~January 2016 ???)**

Addition of more (GNSS) satellites.

Documentation: ftp://cddis.gsfc.nasa.gov/slr/products/ac/jcet_qc.txt

QC Analysis & Reports @ JCET

```
# @151026
# @Data span 151019-151025
# @contact epavlis@umbc.edu
# @website  http://geodesy.jcet.umbc.edu/
# ITRF used:   SLRF2008    (http://ilrs.gsfc.nasa.gov/working_groups/awg/SLRF2008.html)
# @version 1.0
#
# each line contains:
#
# STA ID           = site name
# YY/MM/DD HH:MM   = pass starting time
# SAT              = satellite name (L1: LAGEOS1; L2: LAGEOS2; E1: ETALO1; E2:ETALO2; S1: STARLETTE; A1: AJISAI; LR: LARES
# GOD OBS          = number of good normal points
# RAW RMS          = residual RMS before editing & bias application
# PREC EST         = post-fit scattering rms
# RANGE BIAS       = estimated range bias
# RANGE BIAS SIGMA = estimated range bias sigma
# TIME BIAS        = estimated time bias
# TIME BIAS SIGMA  = estimated time bias sigma
# PASS DUR         = pass duration
# EDIT OBS         = number of bad normal points
# CALIB+ MEAN      = mean Applied System Delay (ILRS FR format cols 97-104)
# CALIB SDEV       = mean System Calibration Method (ILRS FR format cols 126)
# CALIB SHIFT+     = mean Root Mean Square (ILRS FR format cols 111-114)
# STPASS RMS       = mean Pass RMS (ILRS FR format cols 58-64)
# TEMP             = mean surface temperature [K]
# HUM              = mean relative humidity of surface %
# PRES             = mean pressure [hPa]
# WLEN             = walelength [nm]
# SCH              = System Change Indicator (ILRS FR format cols 127)
# SCI              = System Configuration (ILRS FR format cols 128)
# DRF              = Data Release Flag (ILRS FR format cols 130)
# ELEVATION MAX    = maximum elevation for pass [degrees]
# ELEVATION MIN    = minimum elevation for pass [degrees]
#
#7090 Yarragadee  50107M001
                            GOOD       RAW      PREC     RANGE     RANGE     TIME     TIME  PASS  EDIT   CALIB+  CALIB  CALIB++ STPASS   TEMP    HUM     PRES     WLEN  S S D      ELEVATION
#                           OBS       RMS       EST      BIAS      BIAS     BIAS     BIAS   DUR   OBS    MEAN    SDEV    SHIFT   RMS     [K]      %     [hPa]     [nm]  C C R    MAX      MIN
#STA ID YY/MM/DD HH:MM SAT             [mm]      [mm]      [mm]     SIGMA     [us]    SIGMA  [MIN]         [mm]    [mm]    [mm]   [mm]                                    H I F      [degrees]
#
70900513 15/10/19 00:37 L2     5        7.1       2.1       6.8       9.8     10.7      7.6     0      0   15197 E     5       1  P    11    290.3    56.0    990.6    532.0  4 1 0    54.0     44.9
70900513 15/10/19 09:49 L1    18        9.1       2.0       8.9       2.4      1.3      3.2     0      0   15197 E     5       0  P    10    292.5    51.4    987.9    532.0  4 1 0    85.3     21.6
70900513 15/10/19 13:17 L1    16        5.4       1.8      -5.1       7.9      4.2      3.4     0      0   15193 E     5       2  P    10    288.0    67.0    989.1    532.0  4 1 0    29.5     17.2
70900513 15/10/19 14:12 L2    10       16.3       2.3      16.2      12.9     -0.9      5.0     0      0   15193 E     5       2  P    10    287.4    71.0    989.0    532.0  4 1 0    20.6     16.6
70900513 15/10/19 16:37 L1    12       23.3       3.7     -23.0       9.3      3.6      3.2     0      0   15194 E     5       1  P    10    284.7    79.0    988.4    532.0  4 1 0    24.2     19.2
70900513 15/10/19 17:53 L2    21        7.2       3.5       6.3       1.9     -6.0      2.5     0      0   15194 E     5       2  P    10    284.3    79.2    987.9    532.0  4 1 0    83.2     19.2
70900513 15/10/19 19:59 L1    16        3.7       3.7      -0.5       2.6     -1.3      2.5     0      0   15195 E     5       3  P    10    284.9    78.8    987.5    532.0  4 1 0    76.5     14.2
70900513 15/10/19 22:17 L2     8        6.8       3.9       5.5       6.7     -1.1      3.9     0      0   15198 E     5       0  P     9    285.5    75.3    988.0    532.0  4 1 0    43.8     33.2
70900513 15/10/20 08:39 L1    11        5.5       2.3       5.0       4.4     -2.3      2.2     0      0   15196 E     5       0  P    10    298.6    33.5    984.7    532.0  4 1 0    52.2     20.3
70900513 15/10/20 11:59 L1    20        1.8       1.3      -1.2       3.3     -5.6      2.1     0      0   15194 E     5       3  P    10    291.6    53.0    986.5    532.0  4 1 0    46.2     17.1
70900513 15/10/20 15:21 L1    12        6.8       3.0      -6.1       5.3     -7.1      2.6     0      0   15195 E     5      -1  P     9    288.3    59.0    985.9    532.0  4 1 0    19.7     14.9
70900513 15/10/20 16:01 L2    23        7.4       1.9       7.1       3.7     -0.8      2.4     0      0   15195 E     5      -1  P    10    288.3    57.0    985.6    532.0  4 1 0    59.8     25.9
70900513 15/10/20 18:37 L1    13        3.0       2.8      -1.1       3.5     -0.7      2.2     0      0   15195 E     5       1  P    10    287.3    64.0    984.5    532.0  4 1 0    49.7     18.9
70900513 15/10/20 20:09 L2     9        3.0       2.3       2.0       7.2     -7.8      4.1     0      0   15194 E     5       0  P    10    287.0    67.0    984.8    532.0  4 1 0    49.2     28.1
70900513 15/10/20 22:03 L1    20        2.6       2.4      -1.2       3.4      1.2      2.4     0      0   15198 E     5       0  P    10    287.7    68.2    984.9    532.0  4 1 0    48.7     16.1
70900513 15/10/21 00:33 L2    11        6.8       2.6       6.3       3.2      2.6      3.5     0      0   15197 E     5      -1  P    12    295.3    40.0    985.0    532.0  4 1 0    61.2     41.1
70900513 15/10/21 04:53 L2     9        5.6       3.3       4.5       7.6     10.9      3.9     0      0   15196 E     5       2  P    10    306.0    24.0    982.3    532.0  4 1 0    40.7     21.4
70900513 15/10/21 07:17 L1     6       22.8       4.5      22.3       5.9     -5.5      4.3     0      0   15196 E     5       1  P     7    301.1    37.5    981.9    532.0  4 1 0    25.7     24.1
70900513 15/10/21 10:37 L1    19        4.3       2.1       3.7       2.2     -4.4      2.1     0      0   15192 E     5       0  P    10    292.8    72.1    983.4    532.0  4 1 0    72.0     28.3
70900513 15/10/21 14:07 L1     8        5.0       4.9       0.5       7.7     -6.0      3.0     0      0   15192 E     5       1  P    10    290.1    91.0    984.6    532.0  4 1 0    22.6     18.8
70900513 15/10/21 14:29 L2     7        8.6       5.8       6.3       8.6     -1.3      4.9     0      0   15192 E     5       1  P    12    289.9    91.0    984.6    532.0  4 1 0    27.4     23.1
70900513 15/10/21 17:25 L1     8       18.3       2.9      18.1       7.5     -8.0      2.9     0      0   15193 E     5       0  P    12    289.2    92.0    982.8    532.0  4 1 0    31.6     23.9
70900513 15/10/21 18:07 L2    17        6.0       2.9      -5.2      11.7    -11.4      5.4     0      0   15193 E     5       0  P    10    288.9    92.0    982.2    532.0  4 1 0    64.5     25.5
```

The report contains the usual quantities as in other QC reports and in addition, the Site Configuration and History flags, as well as the minimum and maximum elevation of each pass.

QC Analysis & Report @ IAC PNT (MCC)

Product: **Pass-by-pass range bias & time bias.**

History: **1997-present (MCC →IAC PNT).**

Frequency: **Currently updated every working day.**

Software: **Stark (MCC-IAC PNT).**

Availability: **web (https://www.glonass-iac.ru/), CDDIS ftp,**

Stations: **operational.**

Satellites: **LAGEOS-1, 2.**

Recent upgrade: **Oracle DB (done).**

Plan: **SLRF2008 → ITRF2014. Adding more satellites.**

Russian Mission Control Center
Residual Analysis Report

Residuals are summarized for the following 3-day arcs:

				wtd rms(cm)
Lageos-1	3-day arc	14.10.15 00:00	17.10.15 00:00	1.4
Lageos-1	3-day arc	15.10.15 00:00	18.10.15 00:00	1.0
Lageos-1	3-day arc	16.10.15 00:00	19.10.15 00:00	1.8
Lageos-1	3-day arc	17.10.15 00:00	20.10.15 00:00	1.6
Lageos-1	3-day arc	18.10.15 00:00	21.10.15 00:00	1.5
Lageos-1	3-day arc	19.10.15 00:00	22.10.15 00:00	1.6
Lageos-1	3-day arc	20.10.15 00:00	23.10.15 00:00	1.7
Lageos-1	3-day arc	21.10.15 00:00	24.10.15 00:00	1.8
Lageos-1	3-day arc	22.10.15 00:00	25.10.15 00:00	1.8
Lageos-1	3-day arc	23.10.15 00:00	26.10.15 00:00	1.3
Lageos-1	3-day arc	24.10.15 00:00	27.10.15 00:00	1.3
Lageos-2	3-day arc	14.10.15 00:00	17.10.15 00:00	1.4
Lageos-2	3-day arc	15.10.15 00:00	18.10.15 00:00	1.0

MLRO (7941)

	DATA	T ini	T fin	SC	TTL	INC	ME	RMS	ORMS	ELEV	T	P	H	CALIB	TB	RB	PRMS	S
							mm	mm	mm	deg	C	mbar	%	mm	us	mm	mm	
7941	16.10.15	22:19	22:23	L2	3	3	10	2	10	021-026	16	960.7	62	70599	*	10	3	
7941	16.10.15	22:35	23:08	L2	18	18	57	19	60	020-052	16	960.6	65	70595	18	43	1	
7941	17.10.15	03:23	03:26	L1	3	3	-10	0	10	041-045	14	960.5	83	70597	*	-10	0	
7941	17.10.15	03:41	03:44	L1	3	3	0	1	1	042-046	14	960.5	88	70597	*	0	1	
7941	17.10.15	10:13	10:32	L1	11	11	8	6	10	022-035	18	962.1	89	70603	7	13	2	
7941	17.10.15	12:49	12:52	L2	3	3	11	0	11	036-041	20	961.3	89	70601	*	11	0	
7941	17.10.15	13:35	13:50	L1	9	9	11	4	12	033-067	20	961.5	89	70601	5	19	1	
7941	17.10.15	16:15	16:19	L2	3	2	5	0	5	024-032	16	961.6	89	70601	*	5	0	
7941	17.10.15	16:35	16:46	L2	5	5	41	4	41	062-065	16	961.7	89	70600	7	41	0	
7941	17.10.15	17:11	17:16	L1	4	4	-5	0	5	026-032	16	962.0	89	70600	*	-5	1	
7941	17.10.15	17:35	17:40	L1	4	4	7	1	7	028-034	16	962.1	81	70600	*	7	1	
7941	24.10.15	07:57	08:18	L1	12	12	-1	2	3	030-043	13	961.8	88	70602	-2	-1	1	
7941	24.10.15	11:11	11:18	L1	5	5	13	2	14	025-036	15	961.8	71	70603	6	24	2	
7941	24.10.15	11:29	11:31	L2	2	2	16	0	16	049-052	16	961.9	74	70604	*	16	0	
7941	24.10.15	14:37	14:52	L1	9	9	19	5	19	037-082	14	962.3	79	70594	6	28	2	
7941	24.10.15	15:09	15:31	L2	12	12	14	3	14	043-067	14	962.5	82	70586	4	17	1	
7941	24.10.15	15:41	15:44	L2	3	3	17	1	17	039-044	13	962.3	89	70586	*	17	1	
7941	25.10.15	06:28	06:28	L1	1	1	16	0	16	028-028	11	964.7	87	70581	*	16	16	
7941	25.10.15	06:35	07:02	L1	12	12	7	2	7	032-058	11	964.8	89	70600	0	7	2	
7941	25.10.15	09:29	09:44	L2	9	9	-4	5	7	023-033	15	965.1	78	70601	-11	5	1	
7941	25.10.15	09:55	10:20	L1	13	13	5	3	5	024-035	16	965.1	74	70602	-2	4	1	
7941	25.10.15	13:11	13:16	L1	4	4	0	1	1	024-036	18	964.0	54	70599	*	0	1	
7941	25.10.15	13:21	13:32	L2	7	7	19	1	19	069-083	18	964.0	51	70599	2	19	0	

Shanghai Astronomical Observatory, CAS

ANALYSIS CENTRE	Shanghai Astronomical Observatory, Chinese Academy of Sciences, Shanghai, China(SHAO)
CONTACT PERSONS	Wang Xiaoya (wxy@shao.ac.cn,Tel:(86)21-34775203) Hu Xiaogong(hxg@shao.ac.cn, Tel:(86)21-34775202)
SOFTWARE USED	SHORD-II
ILRS PRODUCTS	weekly solutions for range biases and time biases of global SLR stations
QC report issued date	unfixed (if required it can be fixed at someday e.g. every Monday)
issued place	email to ILRS (slreport@dgfi.badw-muenchen.de); also see our website (http://cers.shao.ac.cn/en/data-products/slrcentre-en, unfinished

Shanghai Astronomical Observatory, CAS

Satellites used	LAGEOS-1, LAGEOS-2, ETALON-1, ETALON-2, BDS,LARES
Range and time biases estimation methods	calculated for all the stations based on the residual analysis of weekly SLR quick orbit determination.
Plot a time series of range and time biases	Yes, it will be plotted in time by our website. Now it is not automatic.
Future upgrade	SHORD-II Version 2.0 will be used(better models such as CoM, Troposphere model, weighting methods and so on). More satellites will be processed since January 2016.

Fast Delivery Quality Check

	DGFI	Hitotsubashi University	JCET	MCC	SHAO	AIUB combined
satellites	LAGEOS-1,-2;	LAGEOS-1,-2; Etalon-1,-2; Ajisai; Stella; Starlette; LARES; Jason-2; CRYOSAT-2; BEACON-C; GPS; GALILEO; GLONASS	LAGEOS-1,-2; Etalon-1,-2	LAGEOS-1,-2; GLONASS	LAGEOS-1,-2; Etalon-1,-2 BDS LARES	LAGEOS1-2
Frequency	Twice a day	• 6-hours	daily	daily	weekly	daily
Distribution	DGFI ILRS site	web SLReport CDDIS (one for each week)	•CDDIS •e-mail	CDDIS	SLR Report CDDIS	SLReport

ILRS Combined Range Bias Report 1

Compiled by SLR Observatory Zimmerwald for LAGEOS1-2

Author: Martin Ploner

ILRS Combined Range Bias Report 1
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2015-10-06 00:00 UT - 2015-10-16 00:00 UT

Compiled by: SLR Observatory Zimmerwald
Date : 2015-10-16 12:30 UT
E-Mail : martin.ploner@aiub.unibe.ch

1824 GLSL Golosiiv			DGFI		MCC		HIT-U		SAO		JCET	
	sat	wl	rb	pr	rb	pr	rb	pr	rb	pr	rb	pr
1824 2015-10-07 19:27	LAG2	532	-248	36			-194	30			-222	8
1824 2015-10-08 21:31	LAG2	532	75	48			86	19			109	12
1824 2015-10-09 19:45	LAG2	532	-19	35			-110	15			-89	6
1824 2015-10-10 17:37	LAG2	532	-83	23			101	58			-87	7
1824 2015-10-10 21:50	LAG2	532	32	47			50	13			45	0
1824 2015-10-14 18:23	LAG2	532	-171	38			-274	17				
1824 2015-10-15 16:46	LAG2	532	-254	10								
1824 Average		532	-95	33			-56	25			-48	6

1868 KOML Komsomolsk			DGFI		MCC		HIT-U		SAO		JCET	
	sat	wl	rb	pr	rb	pr	rb	pr	rb	pr	rb	pr
1868 2015-10-07 16:02	LAG2	532	158	5			157	3			173	5
1868 Average		532	158	5			157	3			173	5

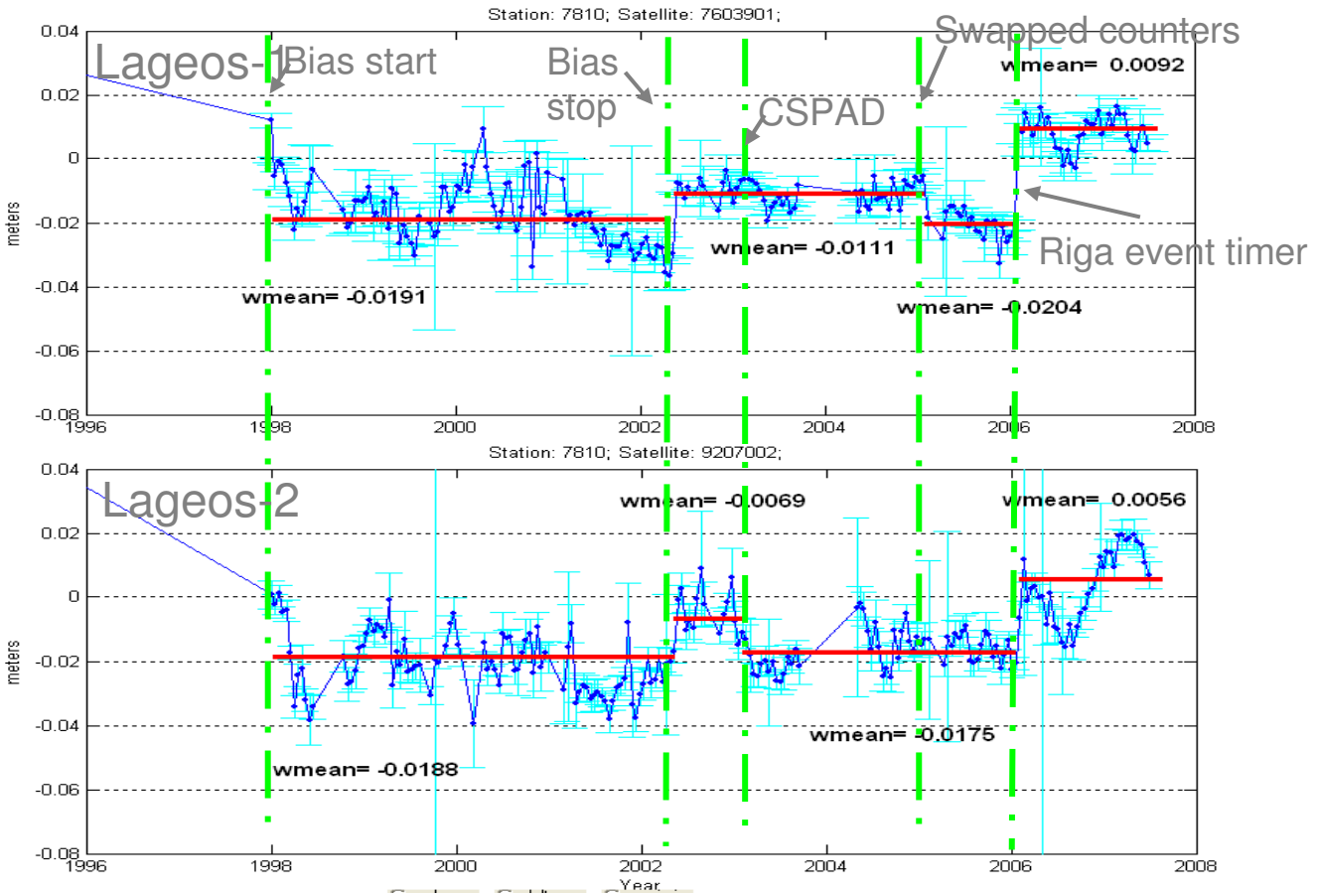
Short term and long term stability

Table 2

Site Information		DGFI Orbital Analysis				Hitotsubashi Univ. Orbital Analysis				JCET Orbital Analysis				MCC Orbital Analysis				SHAO Orbital Analysis			
Station Location	Station Number	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP
Baseline		**10.0**	**20.0**	**10.0**	**95**	**10.0**	**20.0**	**10.0**	**95**	**10.0**	**20.0**	**10.0**	**95**	**10.0**	**20.0**	**10.0**	**95**	**10.0**	**20.0**	**10.0**	**95**
Yarragadee	7090	4.1	23.5	2.9	99.9	2.2	7.5	1.9	100.0	2.7	18.4	2.4	99.4	2.7	20.5	2.7	97.5	2.1	12.6	1.3	92.2
Changchun	7237	6.5	29.3	4.5	99.9	5.5	24.9	6.1	99.9	2.5	28.8	7.1	96.3	5.4	30.6	16.1	95.2				
Mount_Stromlo_2	7825	3.9	19.9	3.6	99.4	2.9	8.9	1.9	100.0	2.2	15.2	3.4	99.1	3.0	15.0	11.5	97.6	1.7	13.7	4.0	96.6
Greenbelt	7105	4.0	17.3	3.2	99.7	2.1	7.3	2.2	99.8	2.3	15.1	3.9	99.1	2.3	15.6	3.6	98.2	2.4	12.3	2.3	91.4
Matera_MLRO	7941	2.5	17.7	6.3	99.8	1.1	8.9	3.6	100.0	1.1	16.3	5.7	100.0	1.3	17.5	4.3	99.5	0.9	14.0	3.5	96.3
Herstmonceux	7840	2.3	16.4	3.1	99.6	1.0	6.0	2.0	100.0	0.7	13.4	3.0	99.3	1.7	14.1	2.1	98.9	0.8	8.8	3.4	98.3
Monument_Peak	7110	4.7	20.5	5.0	99.9	2.0	14.7	4.6	99.9	2.4	19.9	6.1	99.2	2.3	18.5	6.5	97.2	1.7	17.8	4.8	91.7
Zimmerwald_532	7810	3.1	18.8	4.5	99.7	1.5	7.2	1.6	99.9	1.1	13.4		99.9	2.7	15.5		97.5	1.5	10.9		94.2
Graz	7839	2.1	13.3	4.5	99.7	1.2	5.6	1.9	100.0	0.3	12.2	5.2	98.6	2.0	11.0	9.7	97.5	0.2	7.0	6.0	99.1
Wettzell	8834	3.6	13.2	4.8	100.0	2.5	7.9	2.7	100.0	2.3	11.6	3.3	99.7	3.0	9.3	8.5	98.6	3.0	11.6	5.1	92.9
Shanghai_2	7821	2.2	20.6	5.1	100.0	1.0	9.3	4.1	100.0	0.8	18.1	8.4	100.0	1.2	18.8	9.7	100.0				
Hartebeesthoek	7501	5.6	26.9	8.2	99.9	3.2	8.9	3.4	99.8	3.0	18.7	5.6	96.8	3.1	20.4	6.5	95.2	2.4	16.2	6.2	92.1
Badary	1890	8.9	19.4	5.6	100.0	6.9	18.1	4.9	100.0	4.0	19.9	5.7	93.9	6.0	20.7	7.6	95.5				
Potsdam_3	7841	4.0	14.3	4.9	98.8	1.9	8.4	2.9	99.3	1.7	12.9	4.1	98.4	2.7	14.1	3.7	93.5	1.0	9.2	7.2	95.7
Arequipa	7403	6.8	34.2	26.0	100.0	3.2	35.5	23.1	100.0	3.5	32.8	19.5	97.6	3.5	37.6	25.1	94.6				
Altay	1879	5.0	30.9	17.5	100.0	2.9	23.4	14.9	100.0	2.3	24.1	17.4	99.2	2.5	23.8	10.7	100.0	1.5	15.7	20.2	98.4
San_Fernando	7824	7.9	28.7	20.5	100.0	6.4	22.2	19.8	100.0	3.2	21.6	21.3	94.9	8.2	31.1	10.6	96.2				
Komsomolsk	1868	10.7	61.0	23.4	100.0	5.1	65.6	21.0	100.0					4.6	31.5	23.5	96.9				
Katzively	1893	15.1	20.9	11.4	98.4	13.0	19.7	8.6	96.6	5.7	15.1	9.4	77.5	10.7	23.2	18.8	86.4				
Arkhyz	1886	11.9	35.4	12.6	100.0	9.5	31.3	8.9	99.7	4.7	40.5	19.3	82.7	8.8	27.6	11.9	93.1				
Svetloe	1888	8.1	22.6	4.9	99.8	5.7	21.4	5.8	99.7	4.5	26.1	14.3	93.3	6.9	19.4	7.9	92.9	4.4	27.1	5.7	91.0
Zelenchukskya	1889	7.2	16.4	7.5	98.6	5.1	16.3	8.5	100.0	4.0	15.1	5.6	95.9	6.0	27.6	12.7	97.5				
Simeiz	1873	28.0	44.0	21.7	93.4	26.8	45.3	17.0	97.4	5.2	42.8	13.5	58.8	23.4	43.8	14.6	91.5				
Haleakala	7119	4.4	24.0	4.9	99.8	2.6	8.5	3.3	99.6	2.6	11.4	3.7	98.3	2.9	14.9	5.1	99.1	2.0	16.0	6.0	92.7
Papeete	7124	3.7	16.3	4.9	100.0	2.0	9.2	2.2	100.0	2.3	12.0	5.2	100.0	2.5	19.9	13.6	99.6				
McDonald	7080					4.3	11.7	7.3	100.0												
Brasilia	7407	4.6	25.8	7.4	100.0	4.0	18.6	5.7	100.0	2.7	34.5		100.0	8.0	22.1	14.8	97.6				
Simosato	7838	5.9	25.7	4.8	100.0	3.2	10.3	5.0	99.6	3.3	18.0	5.9	98.1	5.9	26.0	31.3	100.0	2.8	13.1	5.3	91.9
Baikonur	1887	10.3	17.4	22.1	100.0	6.3	14.7	20.3	100.0	6.0	21.4	19.2	95.7	6.1	8.4	8.9	98.8				
Grasse_MEO	7845	5.0	13.8	6.1	99.9	2.6	10.1	4.8	100.0	2.6	20.6	4.2	98.8	3.5	14.1	7.2	95.9	2.7	13.4	4.8	94.8
Mendeleevo	1874	4.8	16.4	6.9	100.0					3.3	10.4		98.0	4.5	7.3	10.1	99.2				
Irkutsk	1891	6.3	12.7		99.9	4.7	10.3	4.4	99.6	3.8	13.6		95.6	5.2	12.1	12.4	98.7				

Multi-year analysis

The goal of multiyear analyses is the recovery of the station time series over its tracking history in order to detect discontinuities, appear/disappear of biases over medium/long term (i.e. months, years)



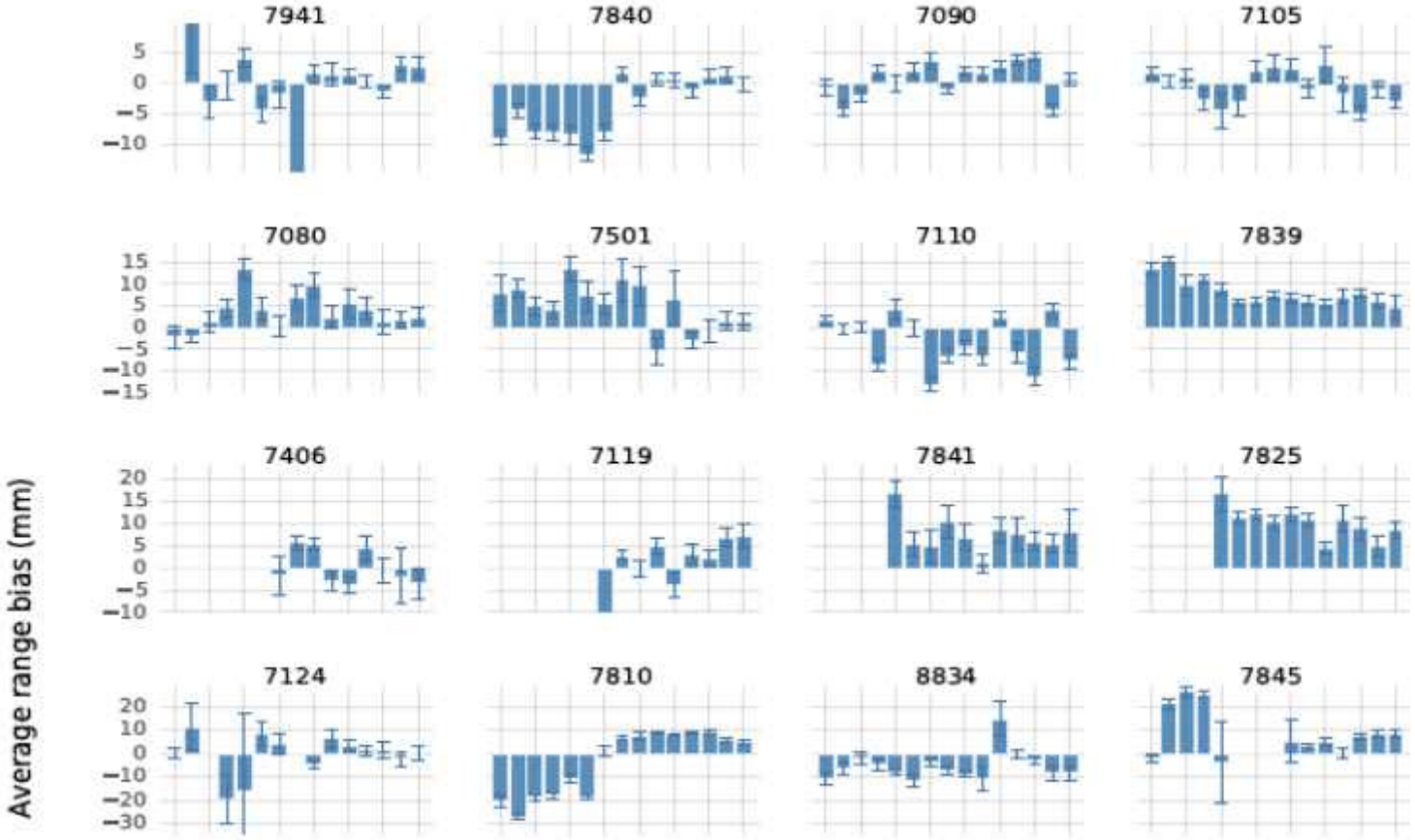
Multi-year analysis

The multiyear analsis was useful when building up the AWG data handling file, now available at the ILRS website and maintained by the AWG (DGFI)

```
7027 --- mm   A 00:000:00000 00:000:00000 C                          new station
*-------------------------------------------------------------------------------
*  list of mandatory range biases to be applied on observation (ILRS/AWG Oct 2007)
*  with updates from ILRS/AWG reprocessing results
*-------------------------------------------------------------------------------
 1873 --- mm   A 95:001:00000 00:001:00000 R      -270.00
 7080 --- mm   A 88:001:00000 89:349:00000 R       -40.00
 7080 --- mm   A 90:094:00000 93:168:00000 R        25.00         IRLS/AWG 14/04/04
 7080 --- mB   A 95:065:00000 96:026:00000 P        -2.10         source CDDIS
 7080 --- mB   A 96:026:00000 96:116:00000 P       -10.30         source CDDIS
 7080 --- mB   A 96:116:00000 96:130:00000 P        -9.70         source CDDIS
 7109 --- mm   A 00:000:00000 88:347:00000 R        10.00         ILRS/AWG 09/05/06
 7109 --- mm   A 97:009:00000 97:018:00000 R       164.90         source CDDIS
 7110 --- mm   A 84:001:00000 84:136:00000 R        30.00
 7110 --- mm   A 87:300:00000 88:025:00000 R        30.00
 7110 --- mm   A 96:240:00000 96:277:00000 R       163.60         source CDDIS
 7122 --- mm   A 84:122:00000 87:074:00000 R        30.00
 7123 --- mm   A 87:195:00000 87:282:00000 R       -30.00         source CDDIS
 7210 --- mm   A 83:001:00000 87:255:00000 R        25.00
 7210 --- mm   A 87:255:00000 94:021:00000 R       -37.00
 7210 --- mm   A 94:021:00000 00:001:00000 R       -11.00
 7237 --- mm   A 96:001:00000 98:001:00000 R       20.000
 7237 --- mm   A 98:001:00000 02:171:00000 R      -20.000
 7249 --- mm   A 01:020:00000 12:001:00000 R       20.000
 7512 --- mm   A 92:061:00000 92:153:00000 R       -30.00
 7517 --- mm   A 92:153:00000 92:245:00000 R       -80.00         ILRS/AWG 13/11/29
```

Multi-year analysis

NSGF analysis



AWG Pilot Project for routine estimation of systematic errors for all sites

•ILRS official product

•open data-base accessible by stations, researchers, public, etc.

Are the analysis results used by the stations?

- An alert is issued by the QC analysis whenever a strong bias is present
- What can we do for smaller biases?
- Any tool available at the station?
- Is it necessary a centralized ILRS tool to be used by the stations for QC, medium/long term bias and bias stability?

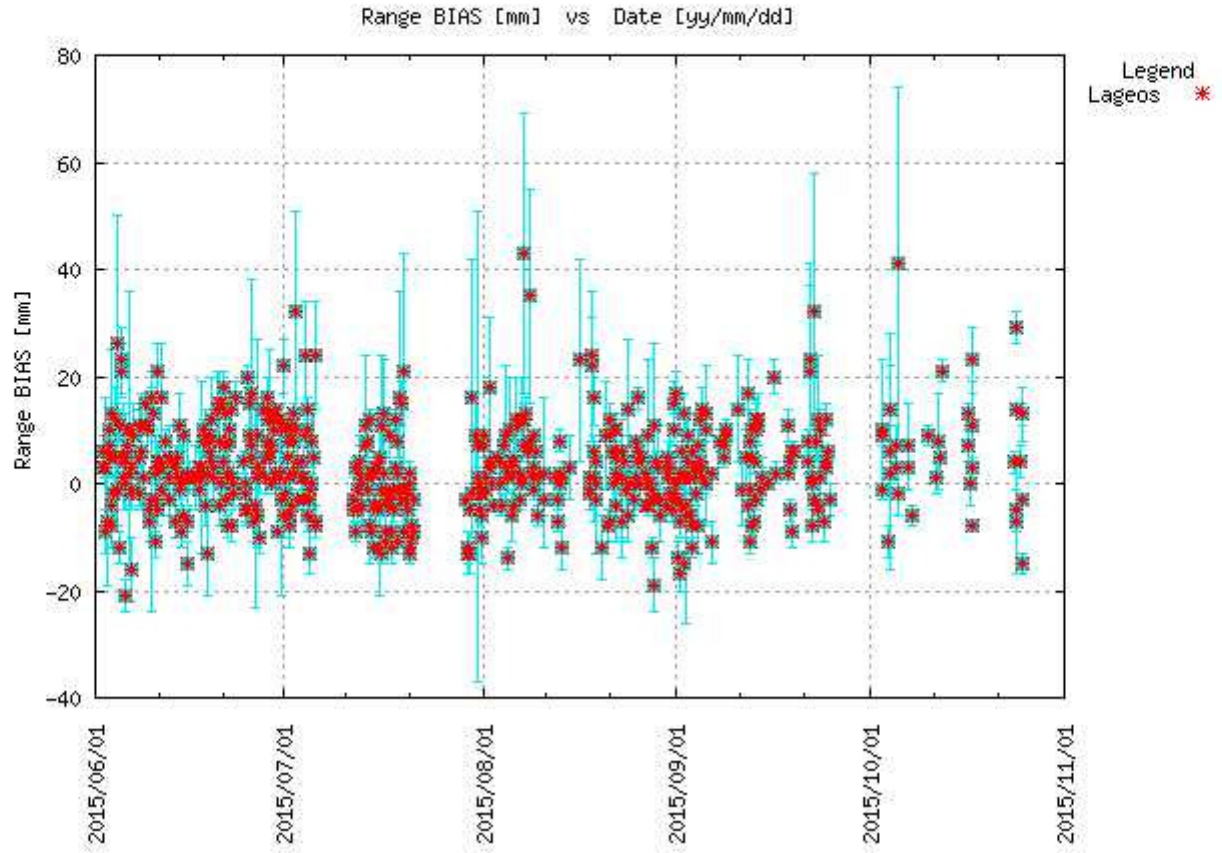
An example at Matera MLRO

An example at Matera MLRO

View Running Mean (available only for X-axis = Time)

Enable Box [days] Step [days] (blank = 0)

View plot



SECOND question

What examples of biases have been seen from the Q/C and final processing systems?

Addressed in the presentation by Toshi Otsubo, responsible of the QC analysis made at HITU

LAST questions

What are the likely sources of biases? What are the big issues?

- Major sources:
  - calibration issues
  - synchronization issues
  - hardware malfunctioning

- Feedback from the stations after a QC alert
- Interactive session given by Toshi
- System Bias Session B