ILRS QCB Meeting

January 19, 2021
Agenda

- Brief on the ILRS contribution to the Reference Frame (Erricos)
- Minimum FR population for NPs on LEO satellites using LARES (John)
- Issues regarding polynomial fits and clipping (Matt)
- The Simosato Story (Van)
- Any updates in Minico results (Van)
- Do any of the satellite C/M models need to be changed to accommodate the new station configurations (Jose)
- More stress on long and short stability rather than NP – How do we implement this?
- History Change Logs
- Document on Best practices (calibrations, barometer, etc.). (Matt)
- Anything else?

Low-return Normal Point Analysis

John C. Ries

1/19/2021

ILRS NPT Guidelines

- *Daytime normal points - minimum 6 data points*
- *Night time normal points - minimum 3 data points*
- *Fewer data points would be acceptable on lower satellites (5-second normal points) from those ranging systems with lower pulse repetition rates where these minimum requirements are not practical.*

- What is the impact of making NPTS with as few as 1 return?
  - In the following, 'low-return NPTs' refers to NPTs with less than 3 returns, though the analysis was extended to 'lower-return' NPTs with less than 6 returns.

Breakdown of NPTS by number of returns
(January 2020 for LAGEOS)

STATION	1SHOT	2SHOTS	3SHOTS	4SHOTS	5SHOTS	6+SHOTS
1873	4	5	5	4	2	28
1884	0	0	0	0	1	27
1888	0	0	0	0	0	45
1890	0	0	0	0	0	129
1893	5	6	4	5	4	47
7090	64	62	44	44	42	703
7105	3	4	4	6	6	268
7110	15	8	5	10	4	282
7119	7	7	4	3	3	101
7237	0	0	0	0	0	301
7249	0	0	0	0	0	17
7501	4	3	1	1	0	94
7810	0	0	0	1	5	1036
7811	0	0	0	0	1	97
7821	0	0	0	0	0	90
7825	0	0	0	0	0	44
7827	0	0	0	0	0	218
7838	3	2	5	7	8	216
7839	0	0	0	0	0	307
7840	0	0	0	0	0	478
7841	0	0	0	0	0	144
7845	0	0	0	0	0	392
7941	7	4	6	2	2	479
8834	0	0	0	0	0	230

A small number of stations are responsible for the low- and low-return normal points.

Look closer at Yarragadee to test impact of successively removing NPTS with only 1 shot, then 2 shots,...up to 5 shots, since it has the most low- and lower-return NPTs, and thus should be impacted the most.

Fit and NPT precision statistics (in mm)
(only a small number of orbit parameters are estimated)

CASE	TOTAL OBS	FIT RMS	B/TB RMS	POLY RMS
test1 (7090 only)	959	7.6	2.9	2.4
test2 "	895	7.4	2.4	2.0
test3 "	833	7.2	2.4	1.8
test4 "	789	7.2	2.4	1.8
test5 "	745	7.2	2.3	1.6
test6 "	703	6.5	1.9	1.6

test1 contains all NPTS (from all stations) but the results for 7090 are shown

test2 uses NPTs with at least 2 returns

test3 uses NPTs with at least 3 returns

Similarly up to test6, which includes only NPTs with at least 6 returns

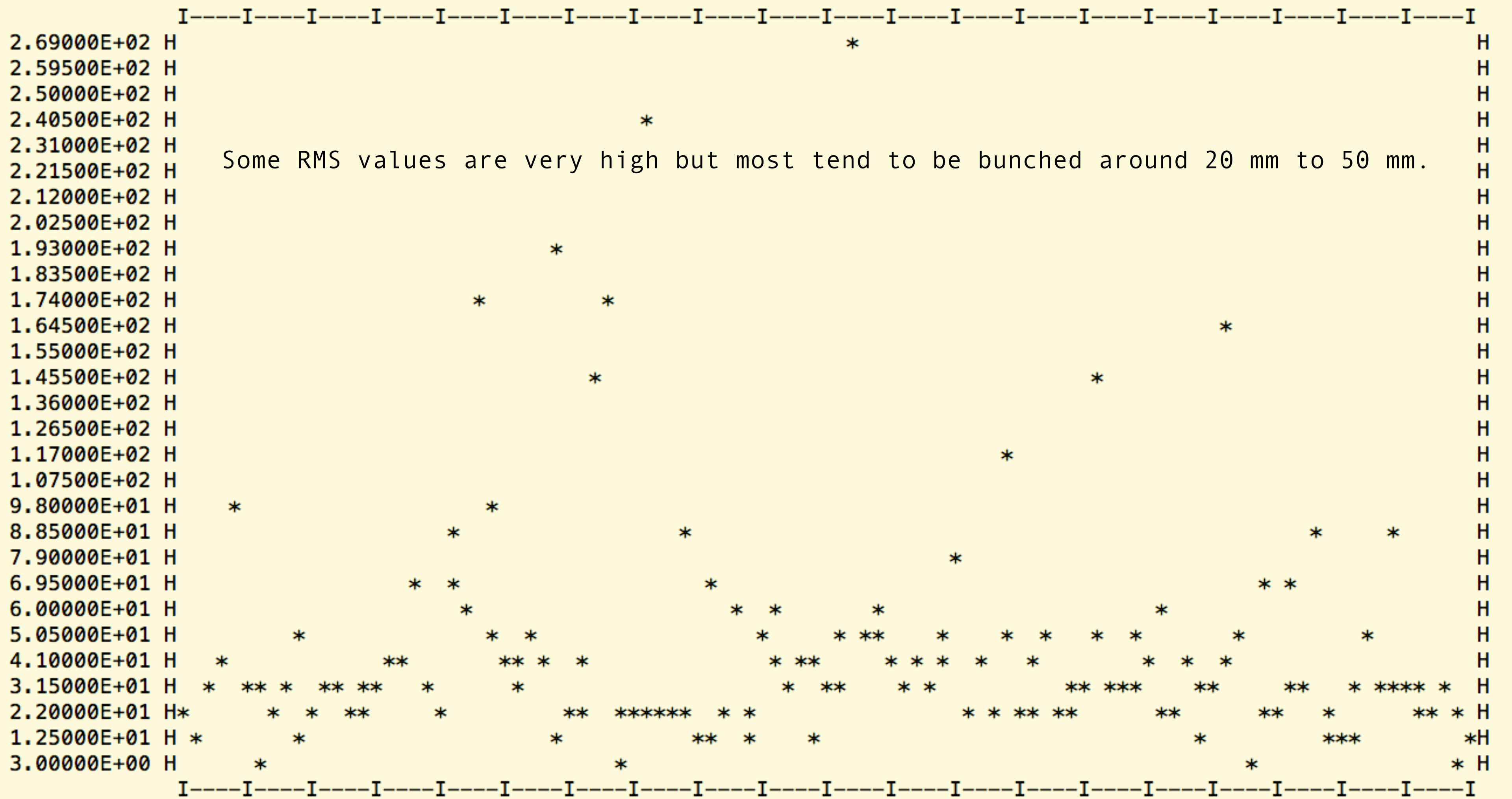
Moving from bottom to top, as NPTs with fewer and fewer returns are included, the FIT RMS degrades. The POLY RMS (the estimated NPT precision) also degrades, indicating that the scatter is significantly worse for NPTs with only 1 or 2 returns.

A few passes are lost if low-return NPTs are excluded, but these are going to be the most unreliable in any case.

However, the impact on the position estimates for 7090 was minor; no difference larger than 0.6 mm was observed for any component (ENU) for any case (31-day estimate; LAGEOS-1; Jan 2020).

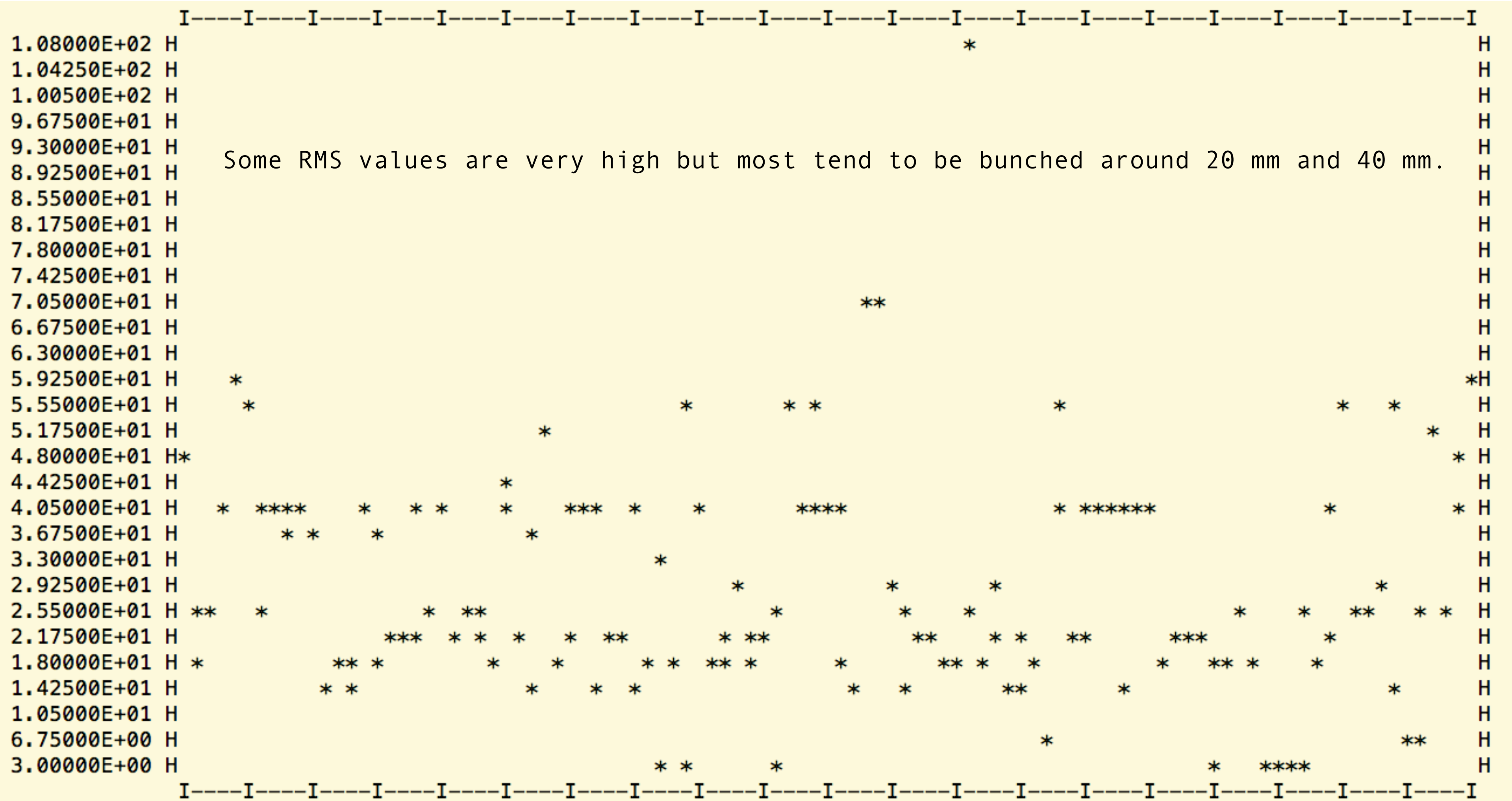
Orbit differences were generally not very significant; low-return NPTs are not a large percentage of the overall tracking. RMS orbit differences were 2-3 mm (RMS) for L1/L2 and 5-7 mm (RMS) for LARES and Starlette.

Assigned NPT RMS for 2-return NPTs



Horizontal axis is simply the count; the ‘ith’ NPT based on 2 returns

Assigned NPT RMS for single-return NPTs



Horizontal axis is simply the count; the 'ith' NPT based on 1 return

Fit statistics for whole network

SLR data for all of 2020 fit using all available NPTs for 4 satellites at various altitudes. Residual RMS was computed for 7 cases: The reference fit RMS used all NPTs, then the RMS was computed for just the 6+ return NPTs, just the 5-return NPTs, just the 4-return NPTs, etc. down to the single-return NPTs.

RMS	All NPTs		6+ Returns		5 Returns		4 Returns		3 Returns		2 Returns		1 Return	
	# NPTs	RMS (mm)	# NPTs	RMS (mm)	# NPTs	RMS (mm)	# NPTs	RMS (mm)	# NPTs	RMS (mm)	# NPTs	RMS (mm)	# NPTs	RMS (mm)
LAGEOS-1	61550	7.1	57708	6.9	634	8.7	645	8.8	727	8.7	834	9.6	1010	10.1
LAGEOS-2	55242	7.4	51002	7.2	738	8.4	711	8.8	811	9.4	895	9.1	1066	10.1
Starlette	83009	27.4	77999	27.0	693	29.2	797	28.3	909	28.5	1050	31.0	1358	31.1
LARES	70071	19.3	63811	18.5	839	21.8	987	21.7	1115	23.5	1369	24.6	1796	24.2
7105														
LAGEOS-1	2913	7.7	2656	7.2	42	9.5	34	10.6	43	12.6	65	11.0	64	11.8
LAGEOS-2	2786	7.1	2452	6.3	49	8.8	48	10.2	62	9.8	71	10.5	92	10.9
7090														
LAGEOS-1	7693	7.2	5870	6.8	275	7.9	316	7.8	333	8.0	388	8.3	506	9.1
LAGEOS-2	6999	7.2	5006	6.9	347	7.2	338	12.6	361	7.9	434	8.0	504	8.5

Range Bias	All NPTs	6+ Returns	5 Returns	4 Returns	3 Returns	2 Returns	1 Return
LAGEOS-1	0.7	0.7	0.9	1.5	1.2	0.8	0.6
LAGEOS-2	1.7	1.6	2.9	2.4	2.5	2.2	2.1
Starlette	0.0	0.0	10.0	7.9	5.0	6.9	6.2
LARES	-0.8	-0.4	-6.6	-4.1	-5.7	-3.9	-5.7

Range bias = network weighted average of residuals (mm) for January-November 2020

(SLRF2014 and ILRS 2013 station-dependent CoM used)
(7-day arcs for L1/L2/LARES, 6-day arcs for Starlette)

There is a significant increase in the noise for all targets, with 1- and 2-return NPTs not surprisingly the worst. Effect was especially apparent for 7105.

For LARES and Starlette, the lower-return NPTs appear to be significantly biased compared to the 6+ return NPTs. No apparent issue for L1/L2.

Downweighting Experiment

Using a simple rule, NPTS were downweighted if they had less than 6 returns. This retains all the data, including passes that are dominantly low-return normal points (small differences in the number of NPTs is due to slightly different points being edited).

RMS	All NPTs		6+ Returns		Downwt	
	# NPTs	RMS (mm)	# NPTs	RMS (mm)	# NPTs	RMS (mm)
LAGEOS-1	68557	7.3	63969	7.1	68558	7.2
LAGEOS-2	60246	7.4	55342	7.2	60237	7.3
Starlette	92042	27.4	86143	27.0	91977	26.7
LARES	75590	19.4	68170	18.6	75431	18.3
7105						
LAGEOS-1	3358	7.7	3077	7.3	3359	7.7
LAGEOS-2	3148	7.2	277	6.5	3147	7.3
7090						
LAGEOS-1	8713	7.3	6616	6.9	8713	7.5
LAGEOS-2	7966	7.1	5693	6.8	7966	7.3

While this simple rule provides some small improvement in the overall RMS for all satellites, it does not necessarily benefit every station. A more sophisticated rule might perform better.

Conclusions (1)

- The FIT RMS increases when low-return NPTs are included.
  - The low-return NPTs are clearly worse than NPTs with at least 6 returns, even in the case of 5, 4 or even 3-return NPTs.
  - For the two smaller (and lower) satellites looked at, a significant bias of 5-10 mm is introduced for NPTs with less than 6 returns.
- There seems to be some inconsistency in computing the RMS for low-return NPTs.
  - Since the uncertainty of a low-return NPT is large, the assigned RMS should probably be correspondingly large.
  - However, the analysts do not generally use it to inform their data weighting in any case, so there does not seem to be much point in trying to impose strict requirements on how to assign the RMS.

Conclusions (2)

- The geodetic impact of the low-return NPTs appears small, but analysts should consider the impact of including NPTs with less than 6 returns.
  - Analysts may want to test the impact of including/excluding any NPT with less than 6 returns, particularly for low satellites, to see the effect on the biases (e.g., Jason-3).
  - Some passes would be lost, but these are also clearly among the least reliable.
  - Where the tracking coverage is already weak, keeping the less reliable NPTs may be better. Keeping them but downweighting them may be reasonable.
  - This should become less of a problem with time as high-rep-rate stations come on line (7840, for example, had only a single NPT with less than 6 returns even when the test NPT software was run to allow for NPTs from as few as a single return).
- A possible analysis strategy would be to include NPTs with less than 6 returns, but downweight them progressively more severly as the number of returns gets smaller.
  - Preserves passes or low-elevation data that might otherwise be lost
  - Testing a simple down-weighting scheme gave mixed results

Range Residuals to Normal Points

- How flat is too flat?

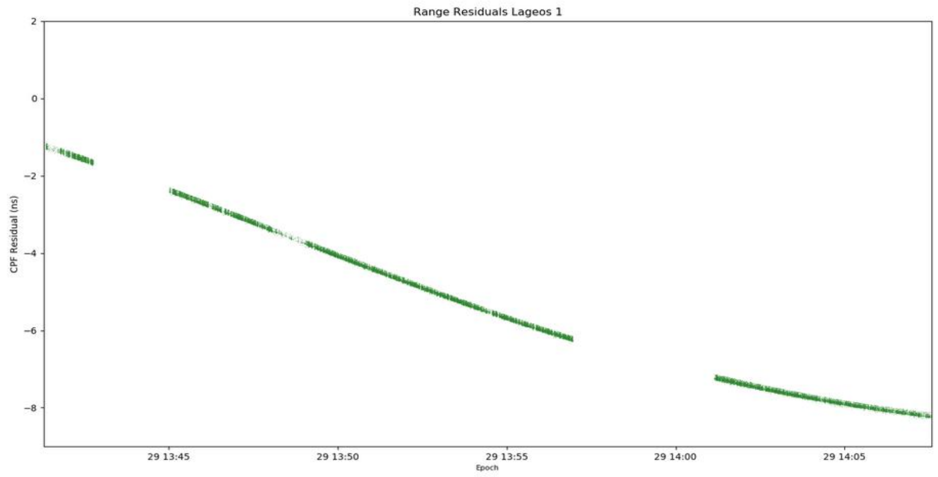
Matthew Wilkinson
SGF, Herstmonceux

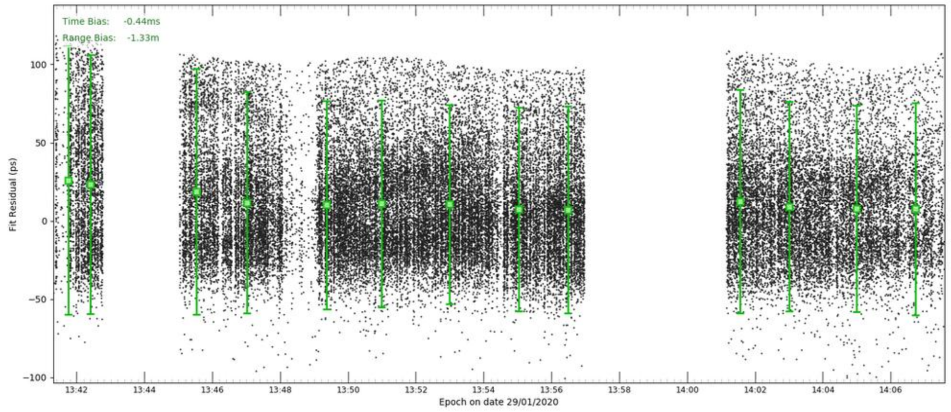
Extracting SLR Returns

SLR ranges are plotted as residuals to a reference orbit.

These O-C residuals must then be flattened in order to form Normal Points.

This is achieved at stations using either **orbital adjustment** or a **high order polynomial fit**.



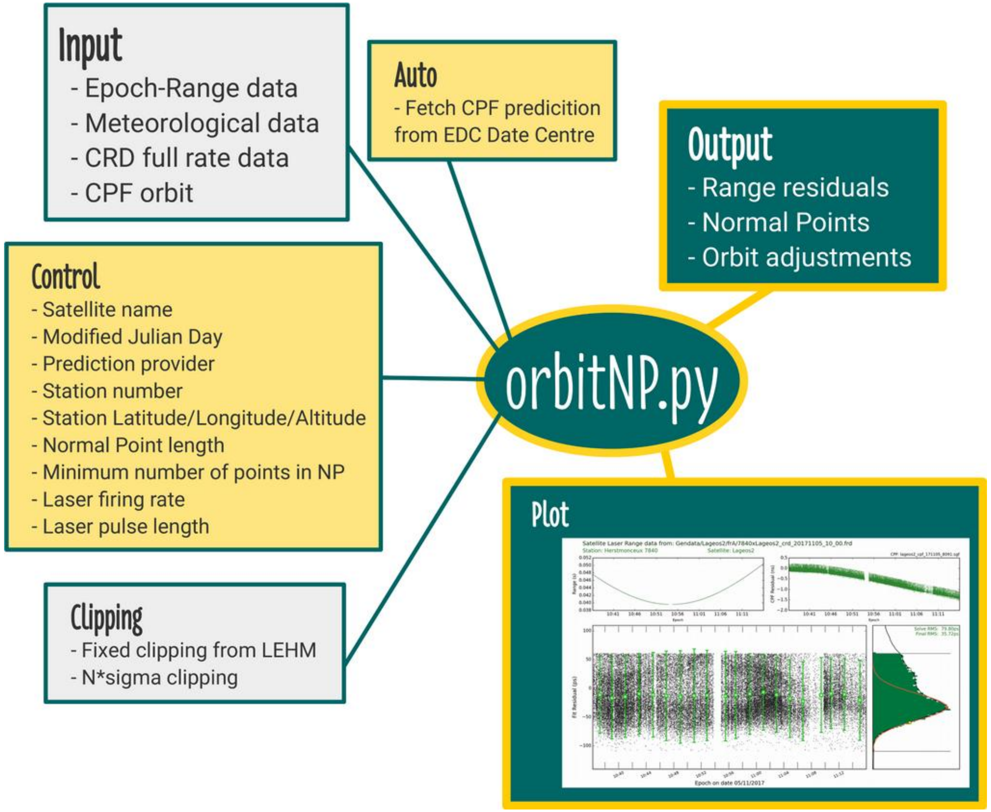


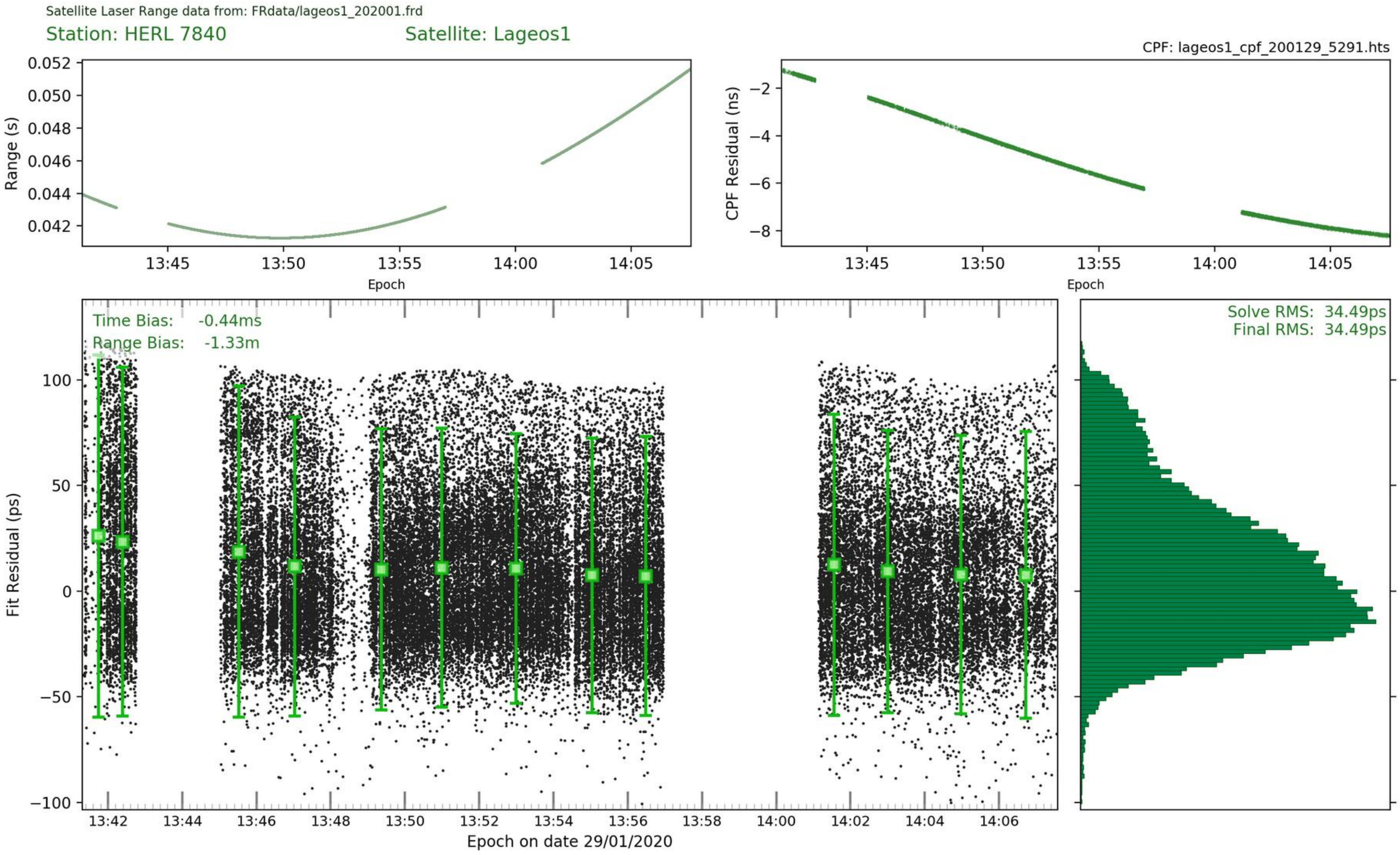
OrbitNP.py

Flattening by orbit adjustment can be achieved using the **orbitNP.py** software.

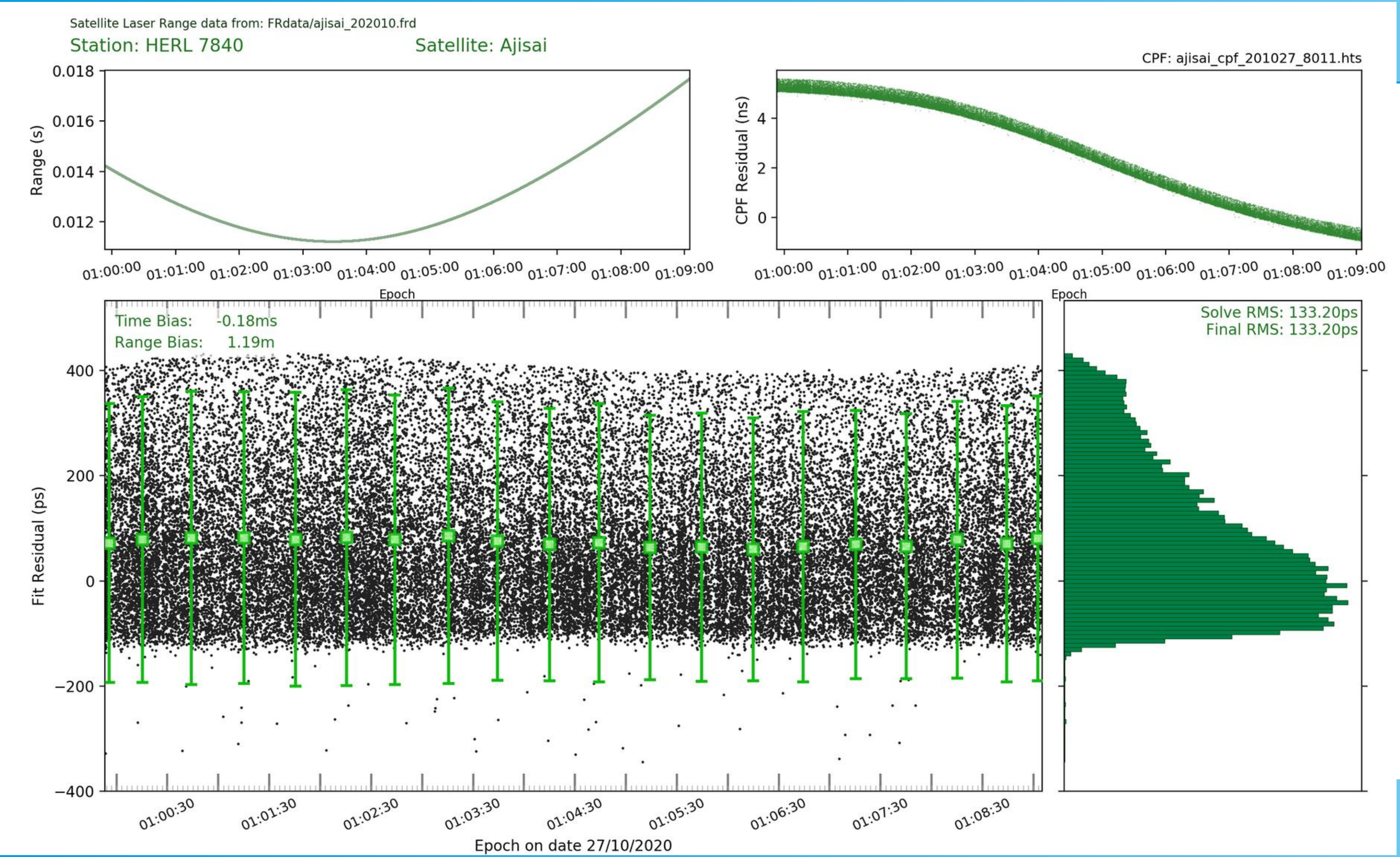
Using this software, it is possible to pick out and process individual passes from full-rate data for all stations and satellites.

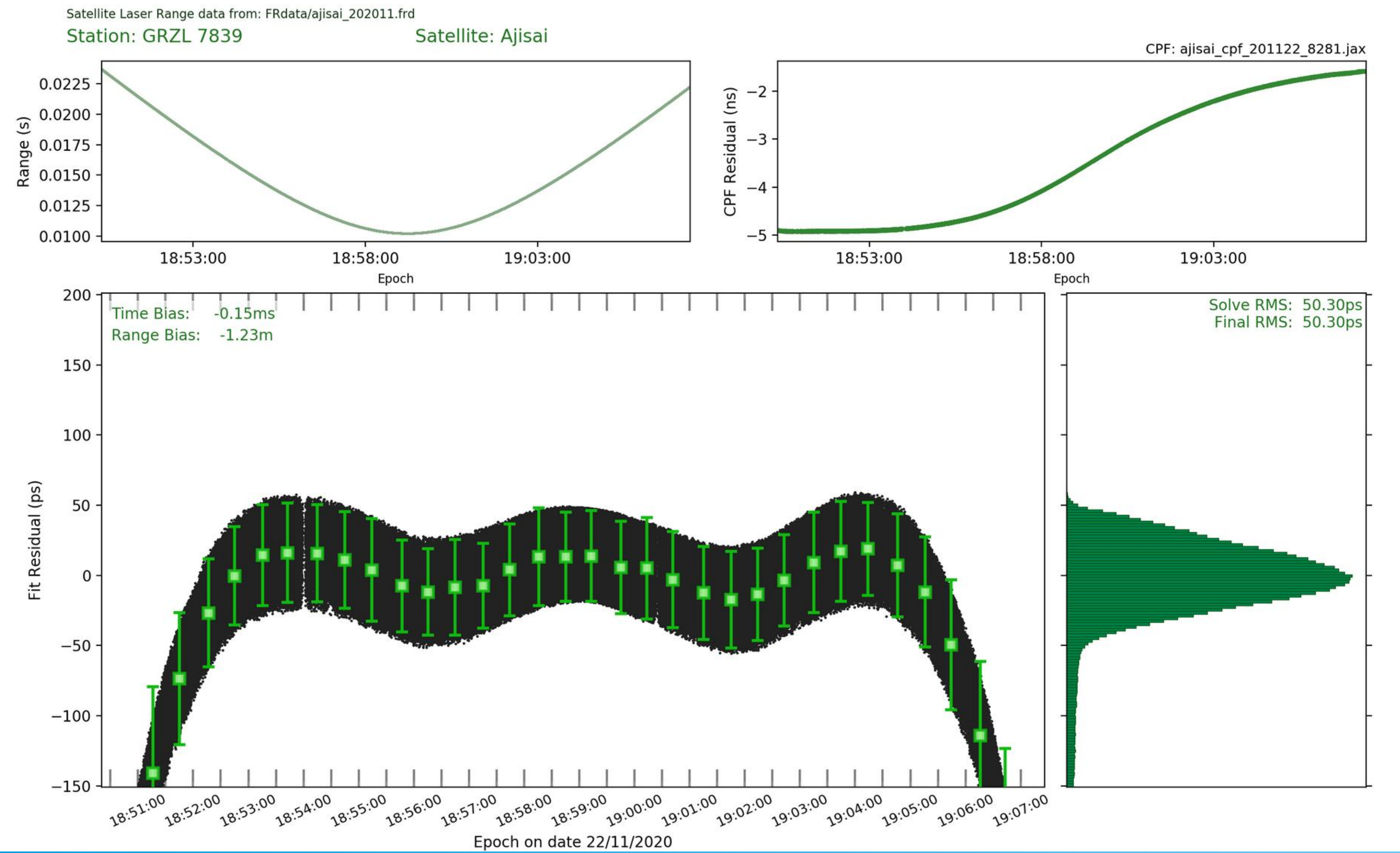
Each station decides the method to form residuals and the data clipping criteria.





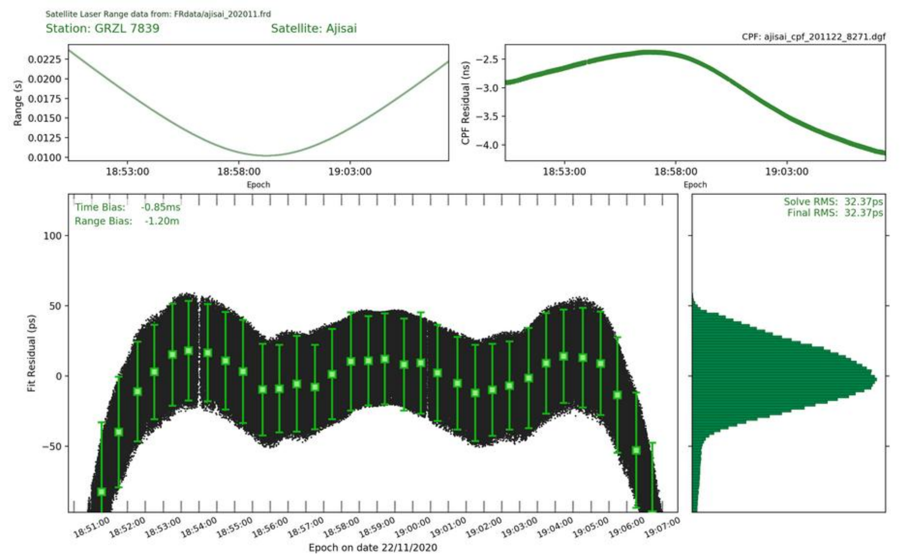
Satellite Laser Range data from: FRdata/lageos1_202001.frd
Station: HERL 7840
Satellite: Lageos1
CPF: lageos1_cpf_200129_5291.hts
Range (s)
Epoch
CPF Residual (ns)
Epoch
Time Bias: -0.44ms
Range Bias: -1.33m
Solve RMS: 34.49ps
Final RMS: 34.49ps
Fit Residual (ps)
Epoch on date 29/01/2020


Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: HERL 7840
Satellite: Ajisai
CPF: ajisai_cpf_201027_8011.hts
Range (s)
Epoch
CPF Residual (ns)
Epoch
Time Bias: -0.18ms
Range Bias: 1.19m
Solve RMS: 133.20ps
Final RMS: 133.20ps
Fit Residual (ps)
Epoch on date 27/10/2020

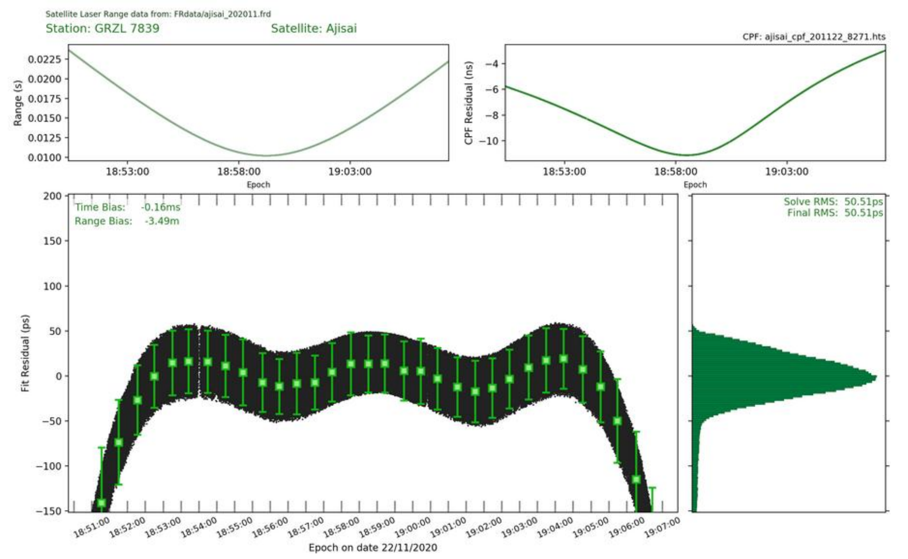


Satellite Laser Range data from: FRdata/ajisai_202011.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201122_8281.jax
Range (s)
Epoch
CPF Residual (ns)
Time Bias: -0.15ms
Range Bias: -1.23m
Solve RMS: 50.30ps
Final RMS: 50.30ps
Fit Residual (ps)
Epoch on date 22/11/2020

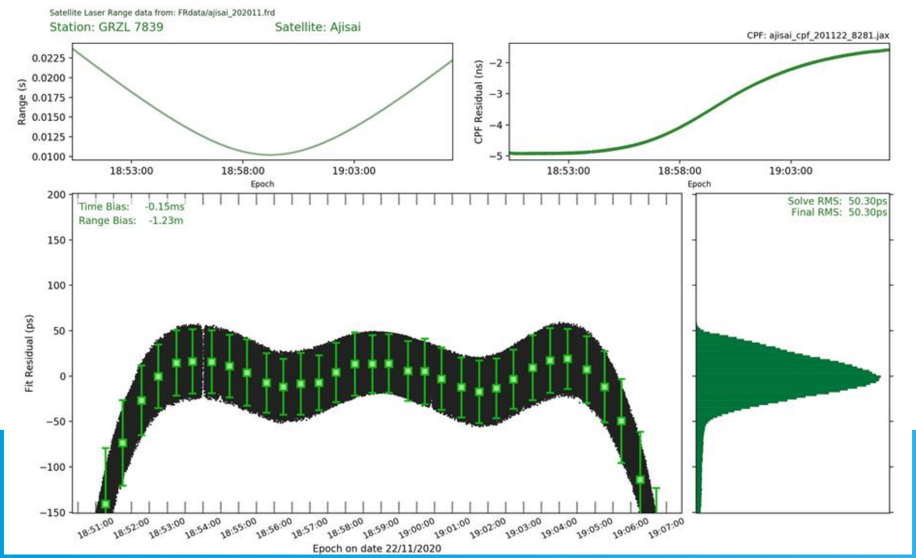
Ajisai
- Graz



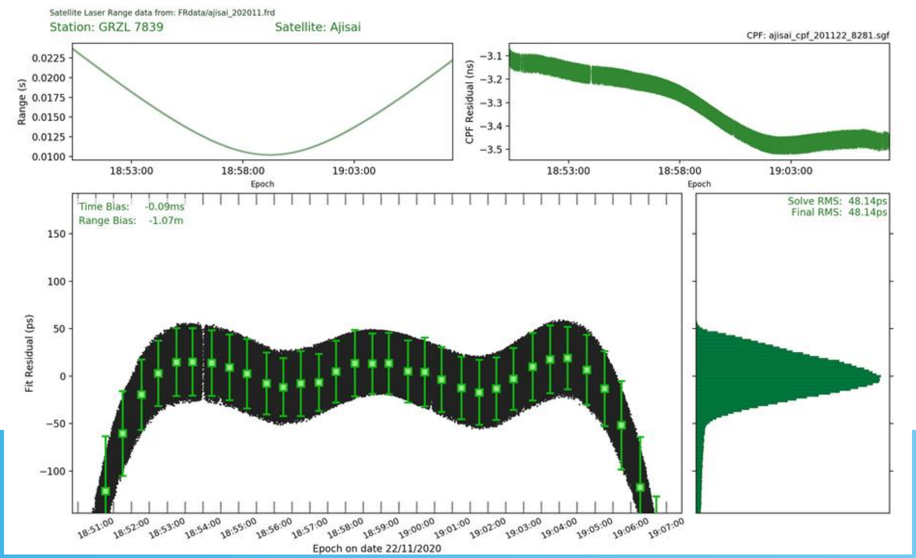
Satellite Laser Range data from: FRdata/ajisai_202011.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201122_8271.dgf
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.85ms
Range Bias: -1.20m
Solve RMS: 32.37ps
Final RMS: 32.37ps
Fit Residual (ps)
Epoch on date 22/11/2020



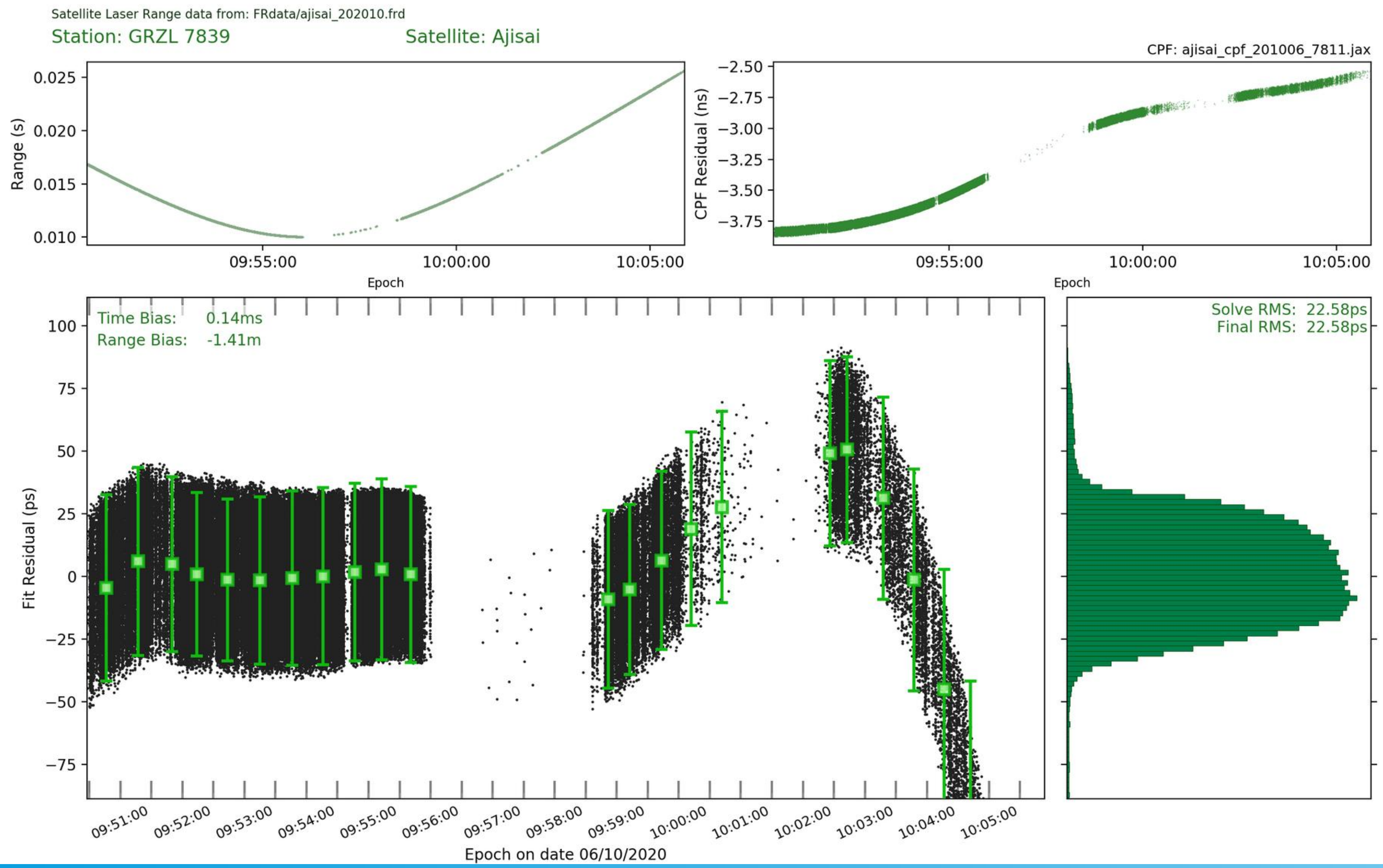
Satellite Laser Range data from: FRdata/ajisai_202011.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201122_8271.hts
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.16ms
Range Bias: -3.49m
Solve RMS: 50.51ps
Final RMS: 50.51ps
Fit Residual (ps)
Epoch on date 22/11/2020



Satellite Laser Range data from: FRdata/ajisai_202011.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201122_8281.jax
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.15ms
Range Bias: -1.23m
Solve RMS: 50.30ps
Final RMS: 50.30ps
Fit Residual (ps)
Epoch on date 22/11/2020

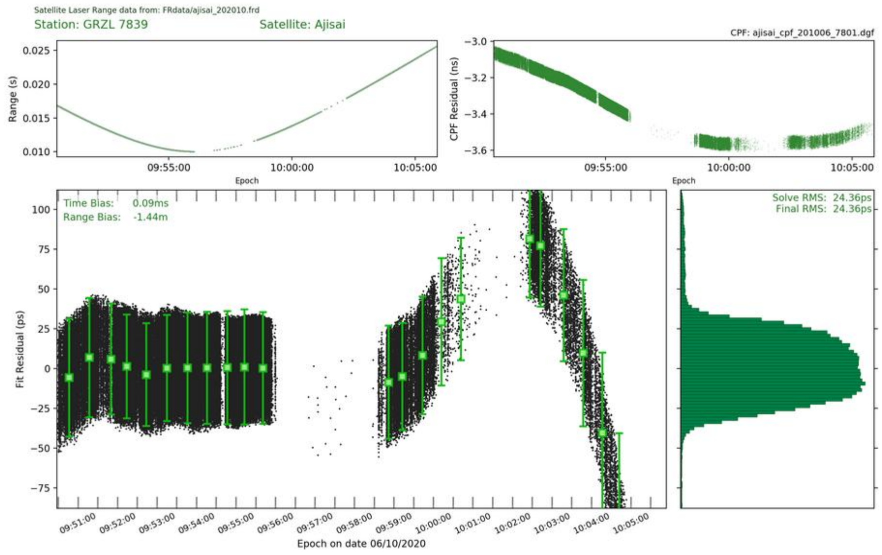


Satellite Laser Range data from: FRdata/ajisai_202011.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201122_8281.sgf
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.09ms
Range Bias: -1.07m
Solve RMS: 48.14ps
Final RMS: 48.14ps
Fit Residual (ps)
Epoch on date 22/11/2020

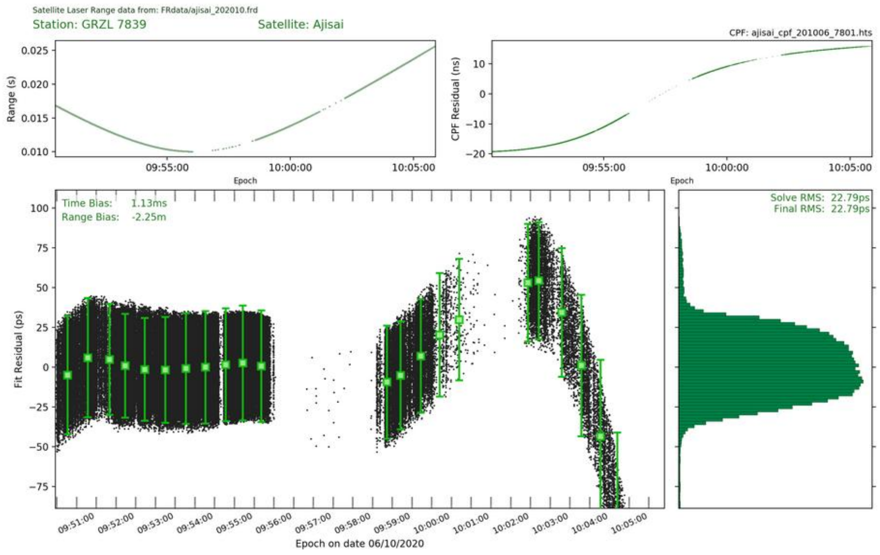


Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201006_7811.jax
Range (s)
Epoch
CPF Residual (ns)
Epoch
Time Bias: 0.14ms
Range Bias: -1.41m
Solve RMS: 22.58ps
Final RMS: 22.58ps
Fit Residual (ps)
Epoch on date 06/10/2020

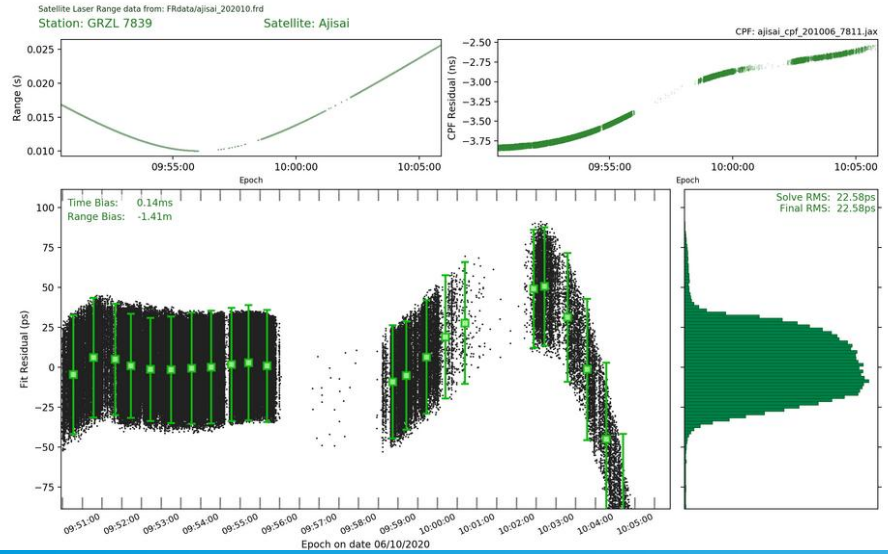
Ajisai
- Graz



Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201006_7801.dgf
Range (s)
CPF Residual (ns)
Epoch
Time Bias: 0.09ms
Range Bias: -1.44m
Solve RMS: 24.36ps
Final RMS: 24.36ps
Fit Residual (ps)
Epoch on date 06/10/2020



Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201006_7801.hts
Range (s)
CPF Residual (ns)
Epoch
Time Bias: 1.13ms
Range Bias: -2.25m
Solve RMS: 22.79ps
Final RMS: 22.79ps
Fit Residual (ps)
Epoch on date 06/10/2020



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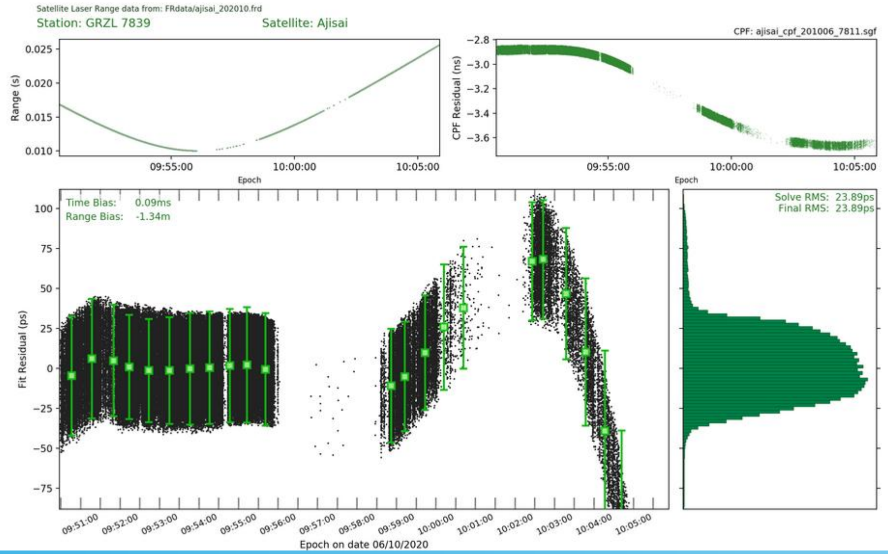
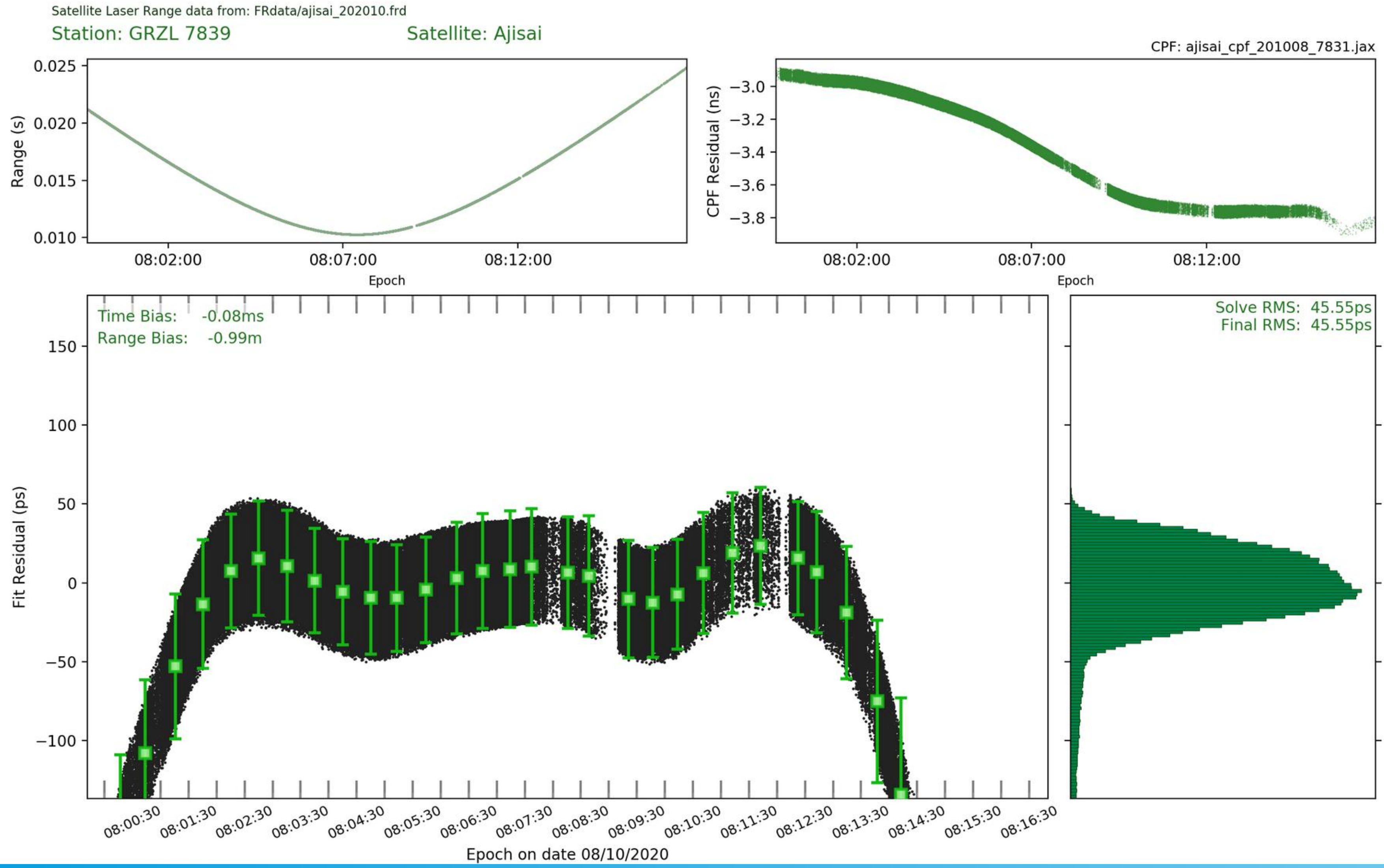
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201006_7811.jax
Range (s)
CPF Residual (ns)
Epoch
Time Bias: 0.14ms
Range Bias: -1.41m
Solve RMS: 22.58ps
Final RMS: 22.58ps
Fit Residual (ps)
Epoch on date 06/10/2020

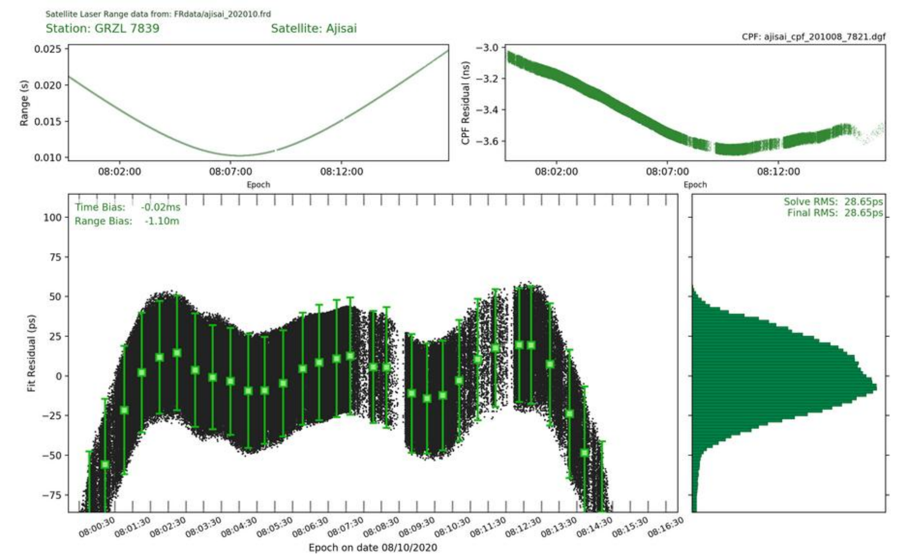


Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201006_7811.sgf
Range (s)
CPF Residual (ns)
Epoch
Time Bias: 0.09ms
Range Bias: -1.34m
Solve RMS: 23.89ps
Final RMS: 23.89ps
Fit Residual (ps)
Epoch on date 06/10/2020

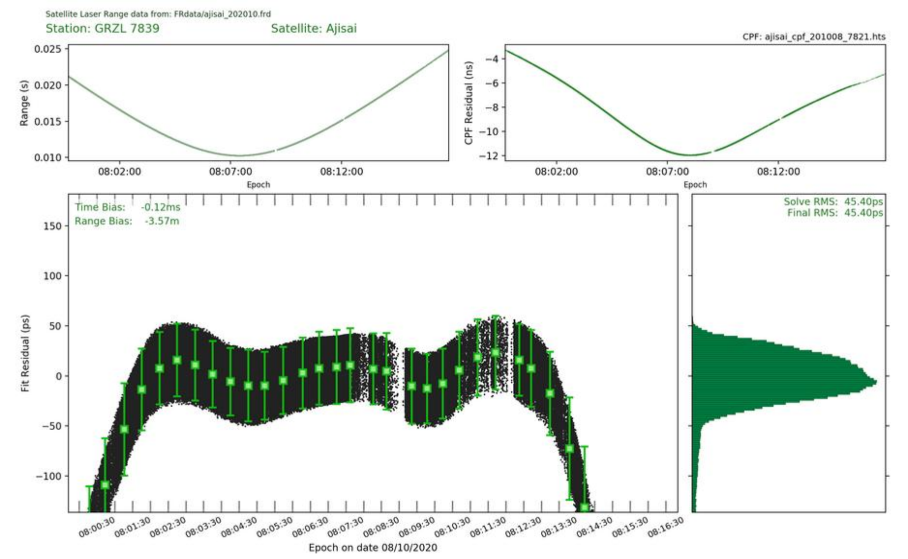


Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201008_7831.jax
Range (s)
Epoch
CPF Residual (ns)
Time Bias: -0.08ms
Range Bias: -0.99m
Solve RMS: 45.55ps
Final RMS: 45.55ps
Fit Residual (ps)
Epoch on date 08/10/2020

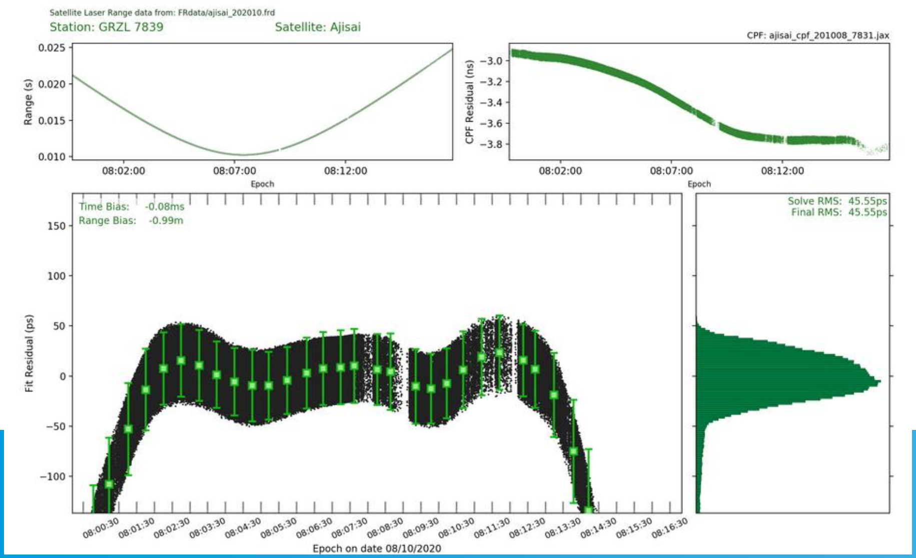
Ajisai
- Graz



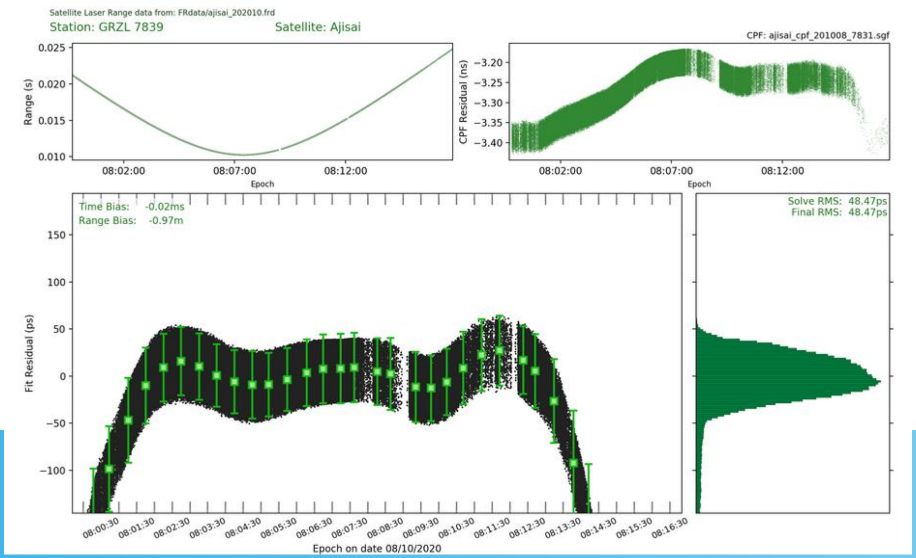
Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201008_7821.dgf
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.02ms
Range Bias: -1.10m
Solve RMS: 28.65ps
Final RMS: 28.65ps
Fit Residual (ps)
Epoch on date 08/10/2020



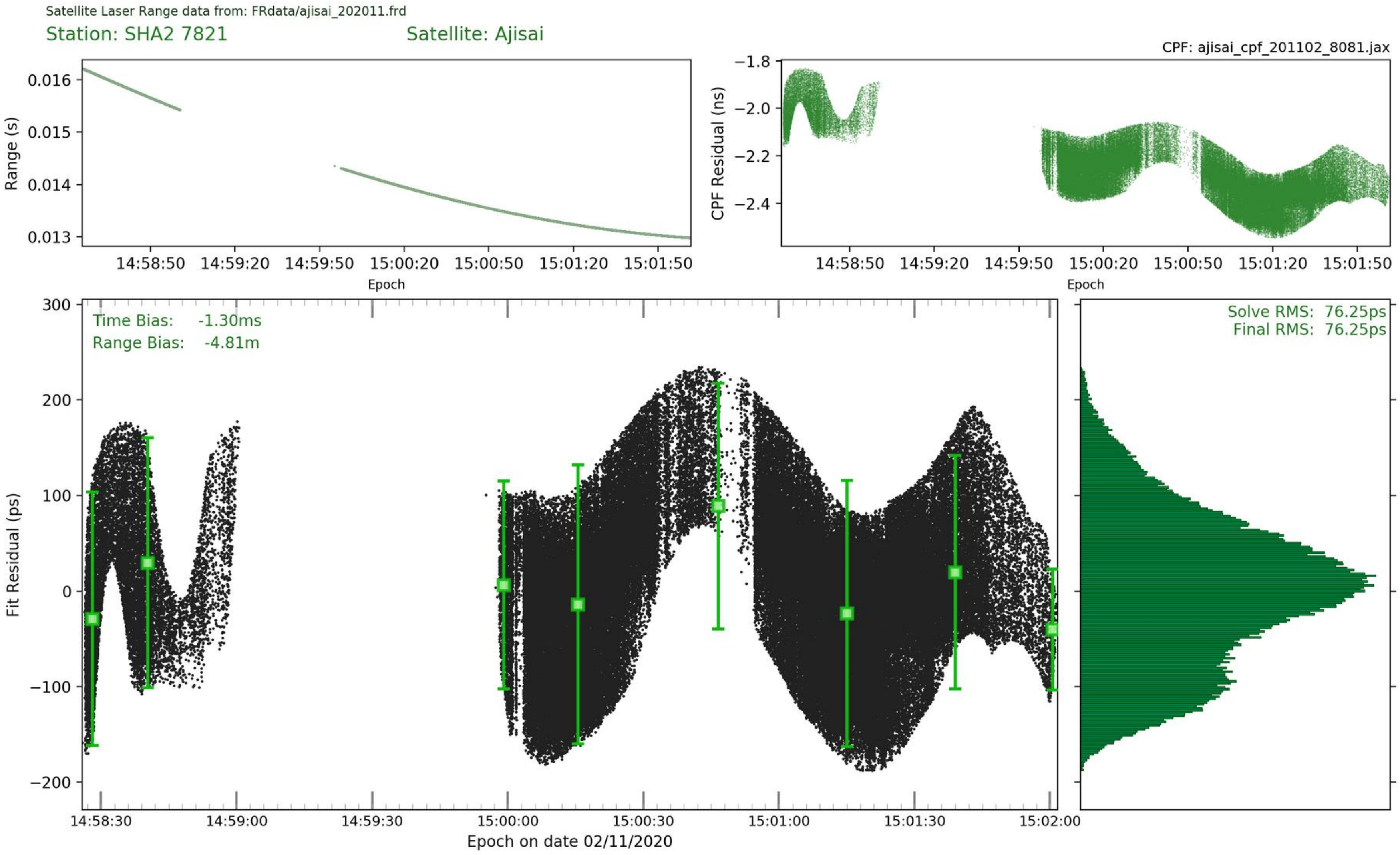
Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201008_7821.hts
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.12ms
Range Bias: -3.57m
Solve RMS: 45.40ps
Final RMS: 45.40ps
Fit Residual (ps)
Epoch on date 08/10/2020



Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201008_7831.jax
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.08ms
Range Bias: -0.99m
Solve RMS: 45.55ps
Final RMS: 45.55ps
Fit Residual (ps)
Epoch on date 08/10/2020

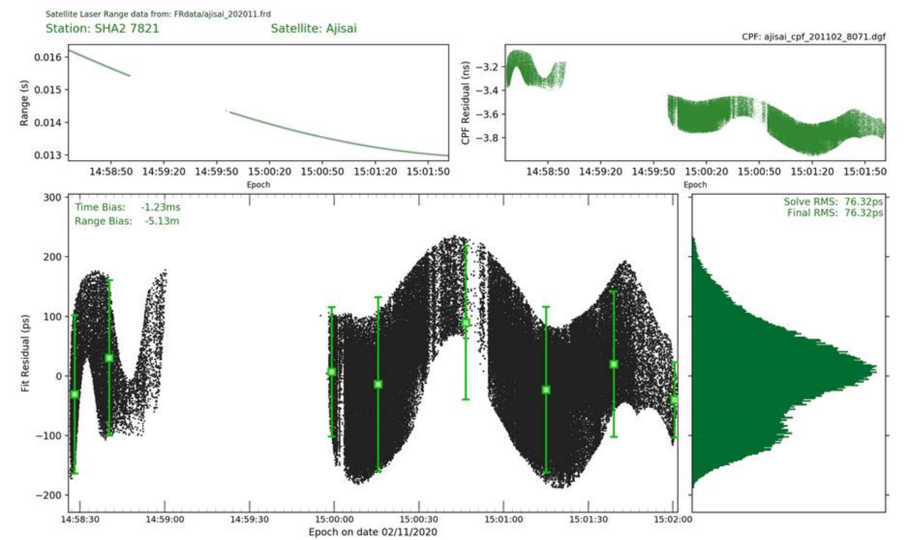


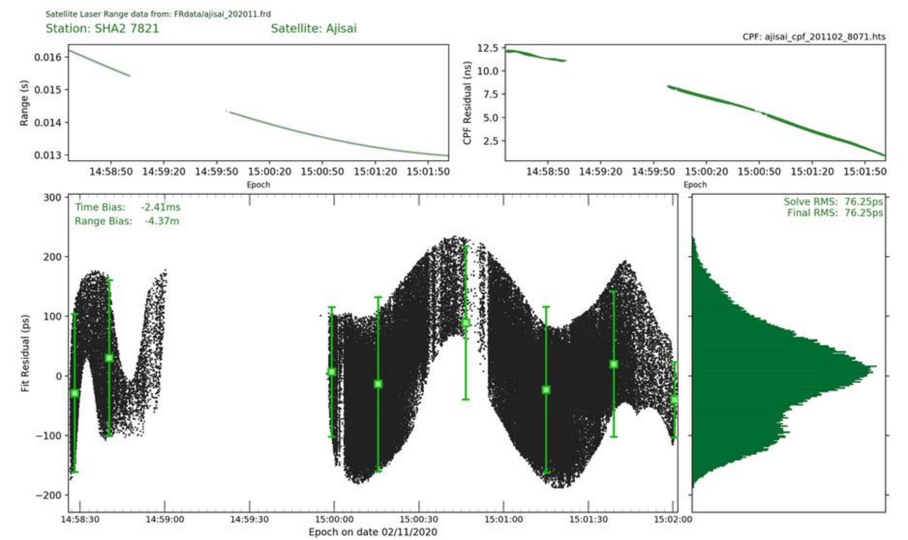
Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: GRZL 7839
Satellite: Ajisai
CPF: ajisai_cpf_201008_7831.sgf
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.02ms
Range Bias: -0.97m
Solve RMS: 48.47ps
Final RMS: 48.47ps
Fit Residual (ps)
Epoch on date 08/10/2020

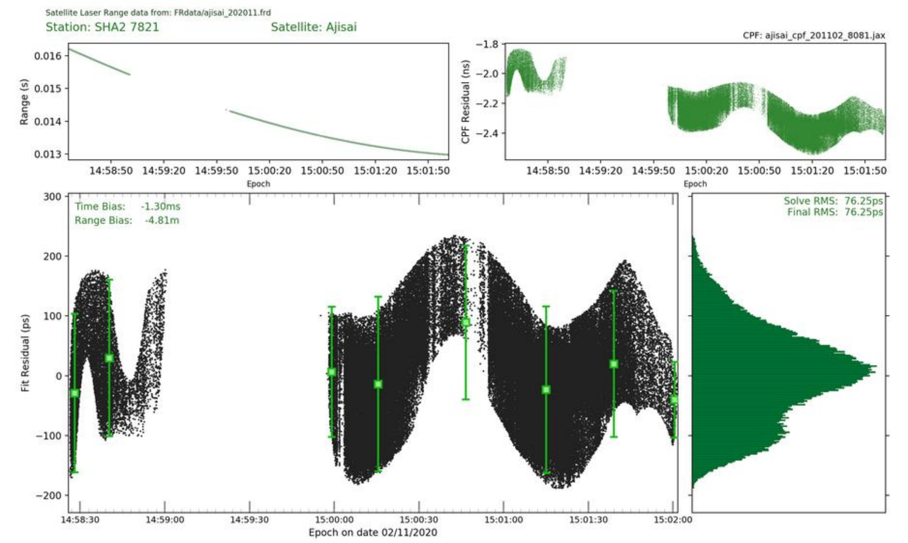


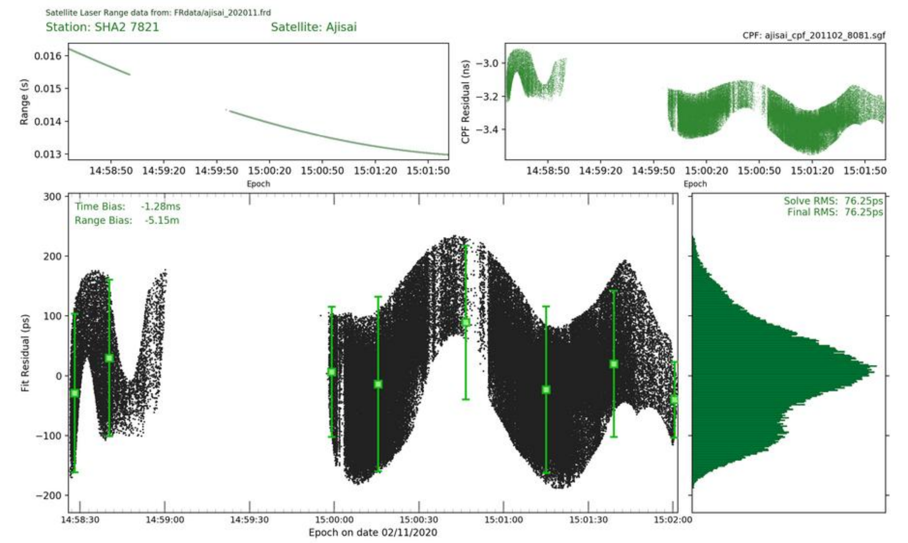
Satellite Laser Range data from: FRdata/ajisai_202011.frd
Station: SHA2 7821
Satellite: Ajisai
CPF: ajisai_cpf_201102_8081.jax
Range (s)
Epoch
CPF Residual (ns)
Epoch
Time Bias: -1.30ms
Range Bias: -4.81m
Fit Residual (ps)
Epoch on date 02/11/2020
Solve RMS: 76.25ps
Final RMS: 76.25ps

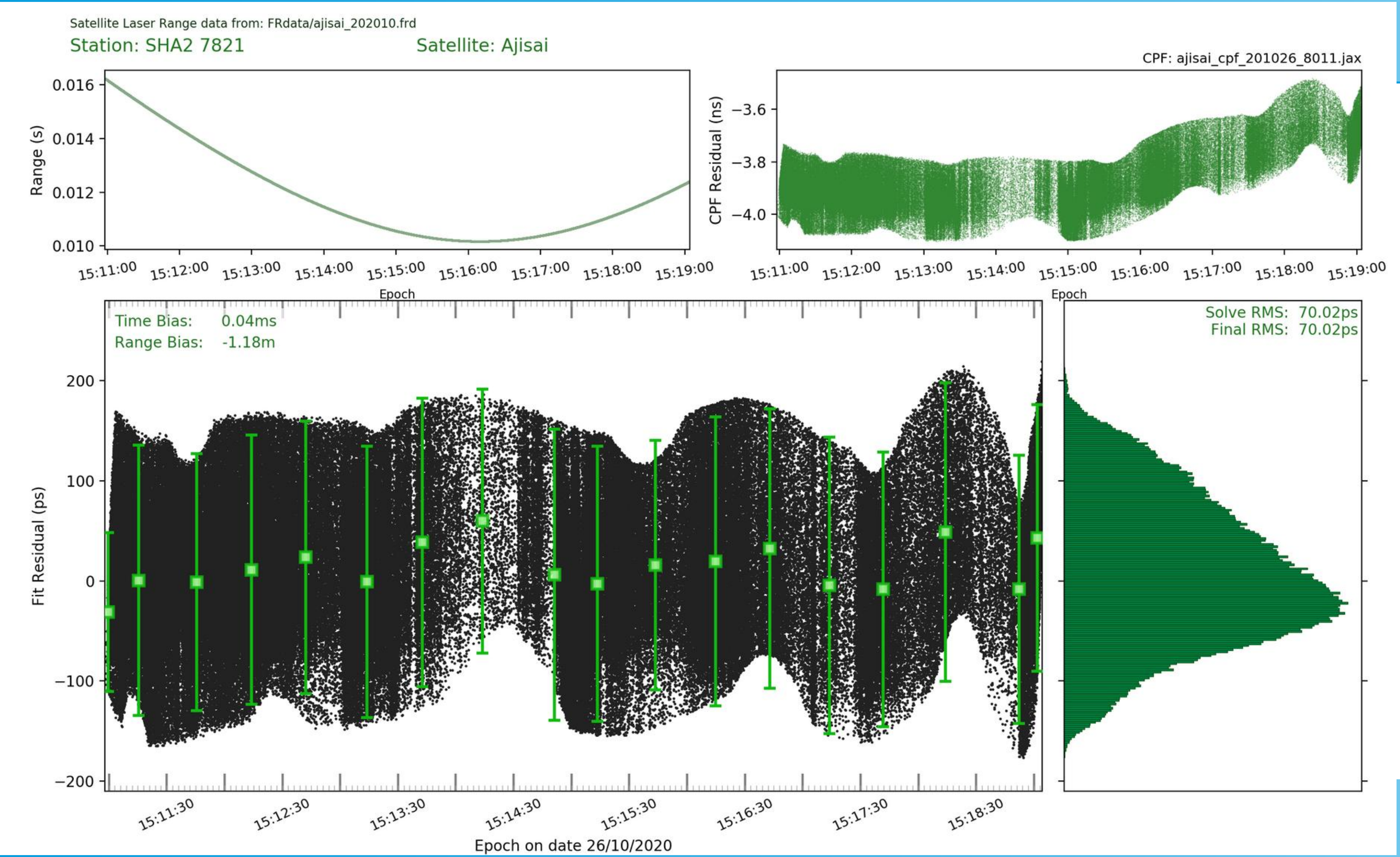
Ajisai
- Shanghai





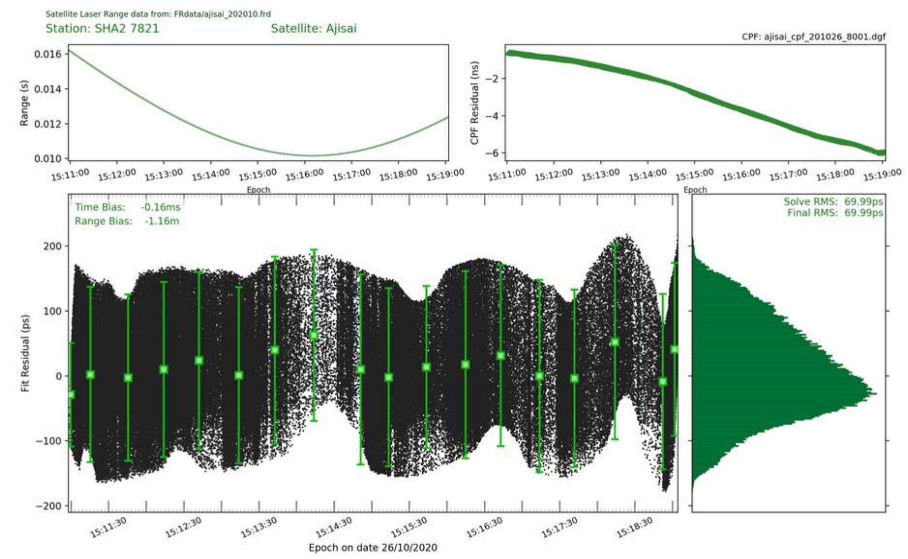


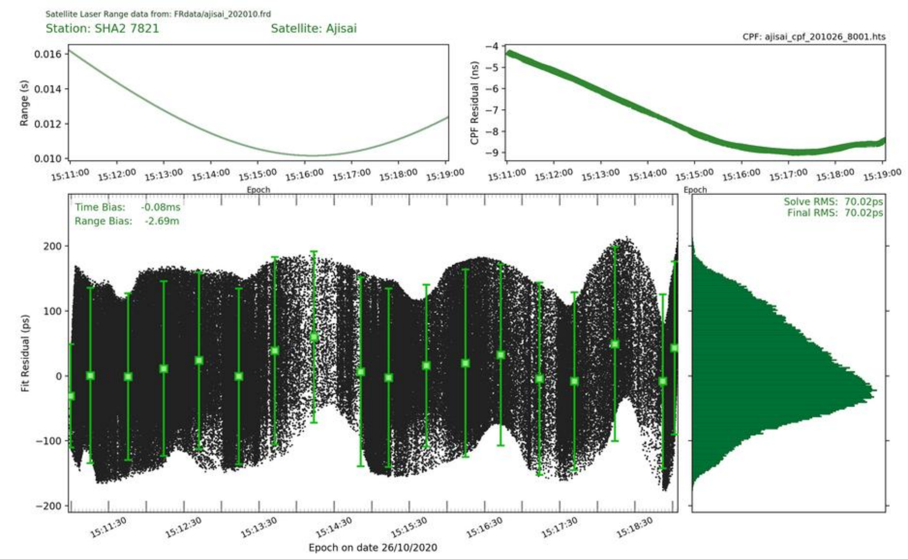


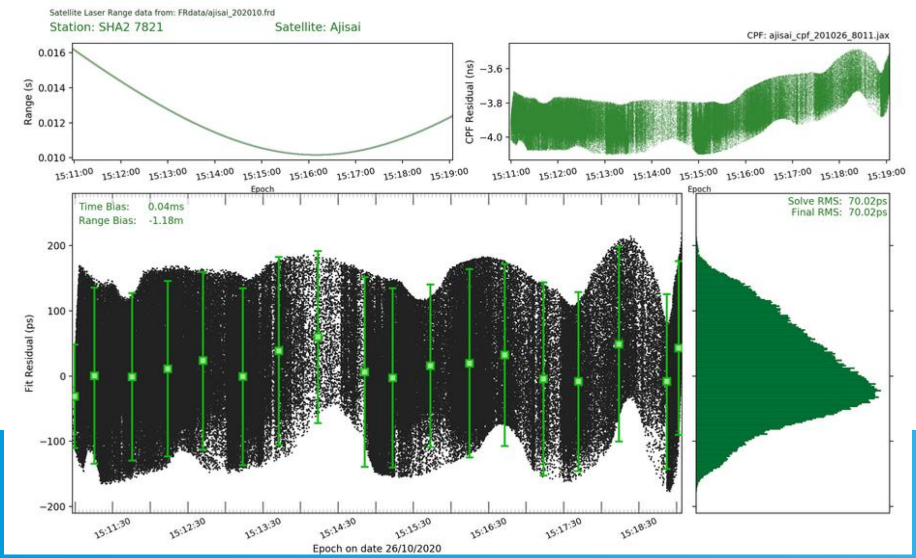


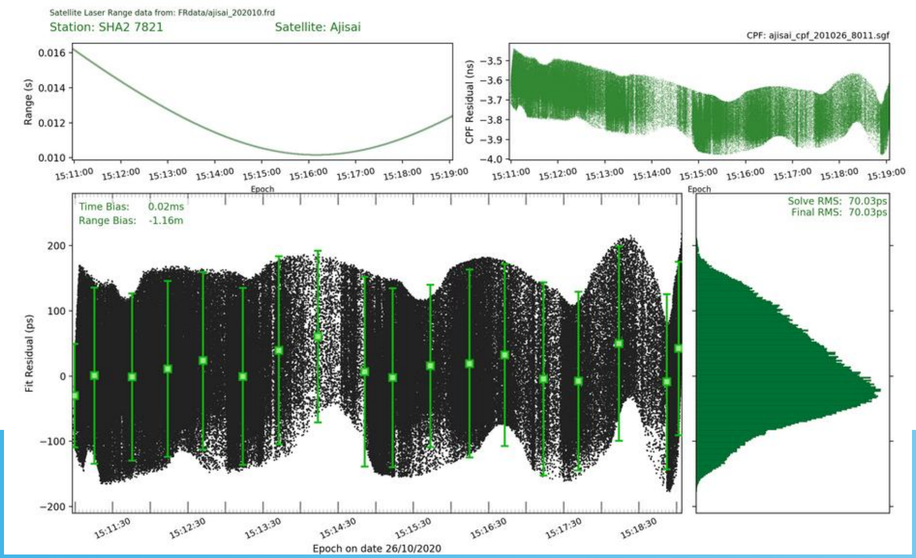
Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: SHA2 7821
Satellite: Ajisai
CPF: ajisai_cpf_201026_8011.jax
Range (s)
CPF Residual (ns)
Epoch
Time Bias: 0.04ms
Range Bias: -1.18m
Solve RMS: 70.02ps
Final RMS: 70.02ps
Fit Residual (ps)
Epoch on date 26/10/2020

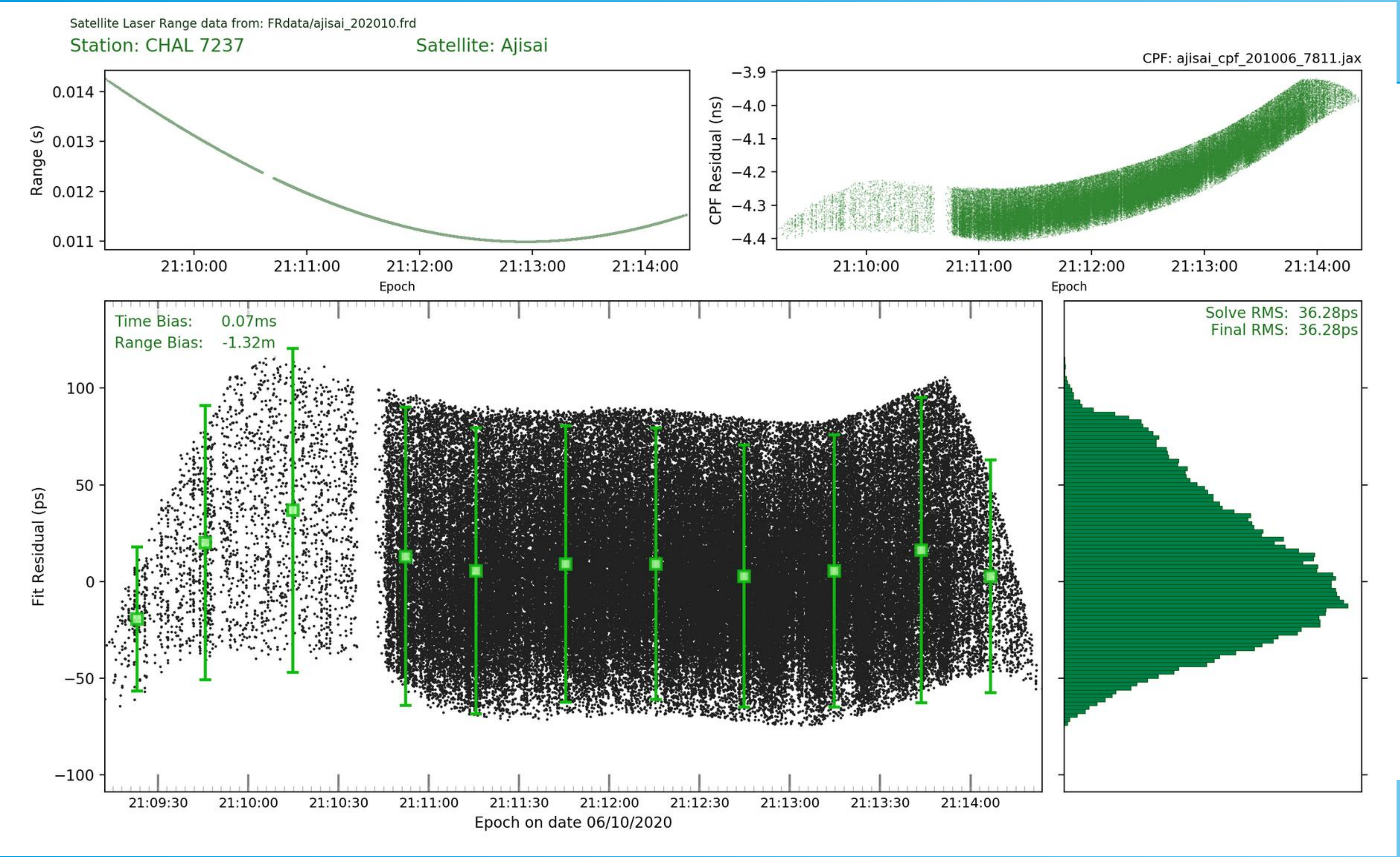
Ajisai
- Shanghai







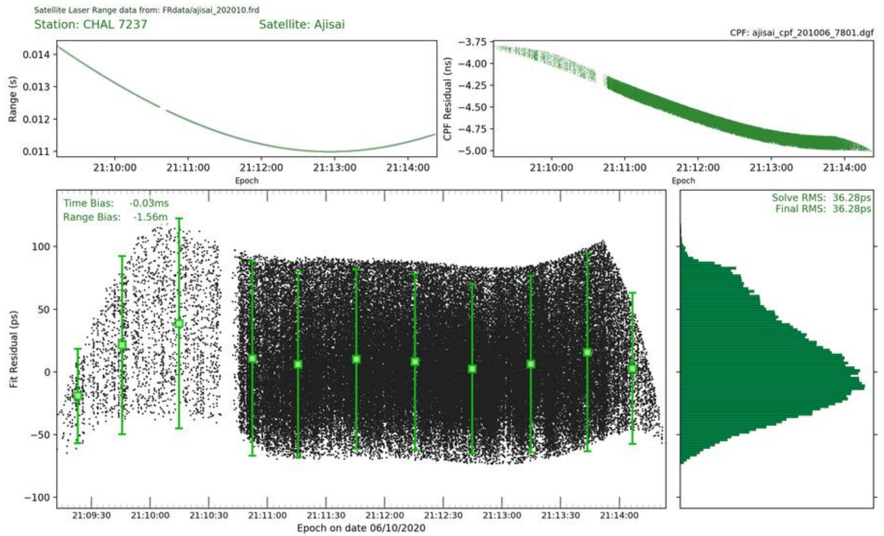


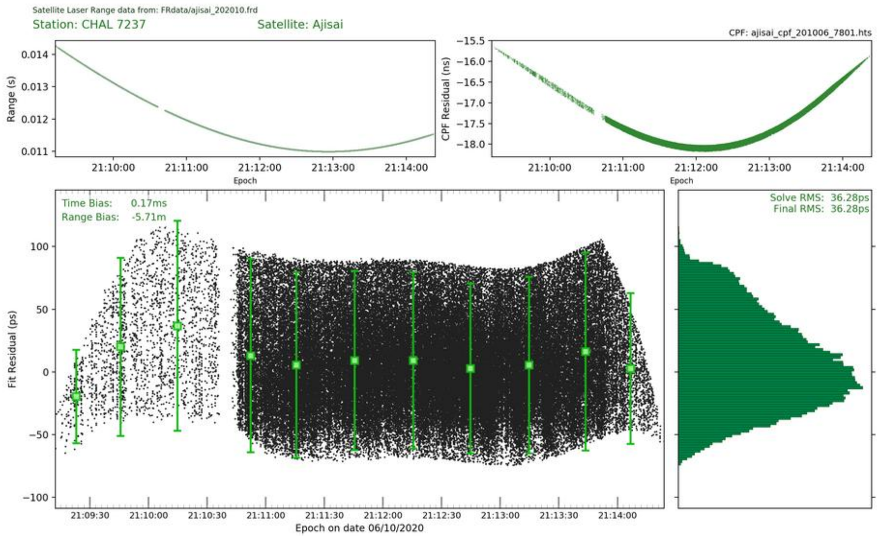


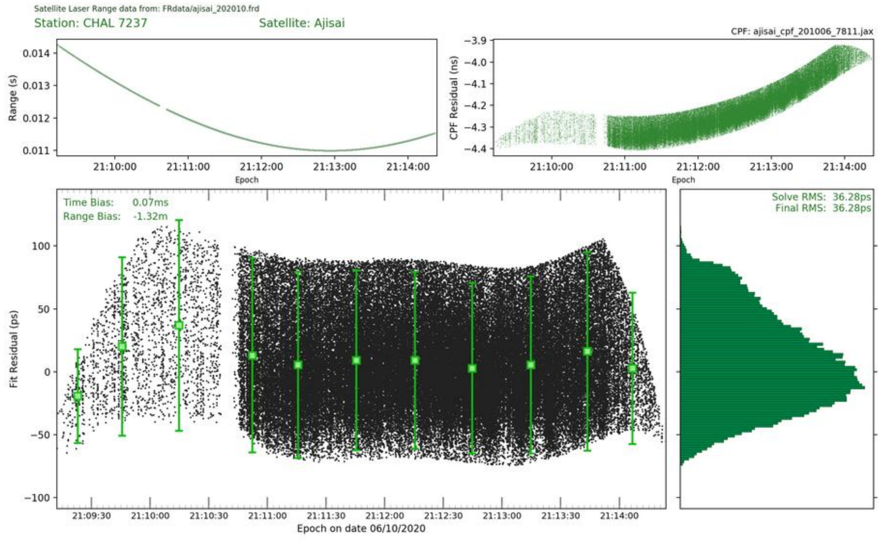
Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: CHAL 7237
Satellite: Ajisai
CPF: ajisai_cpf_201006_7811.jax
Range (s)
0.014
0.013
0.012
0.011
21:10:00
21:11:00
21:12:00
21:13:00
21:14:00
Epoch
CPF Residual (ns)
−3.9
−4.0
−4.1
−4.2
−4.3
−4.4
Epoch
Time Bias: 0.07ms
Range Bias: -1.32m
Solve RMS: 36.28ps
Final RMS: 36.28ps
Fit Residual (ps)
100
50
0
−50
−100
21:09:30
21:10:00
21:10:30
21:11:00
21:11:30
21:12:00
21:12:30
21:13:00
21:13:30
21:14:00
Epoch on date 06/10/2020

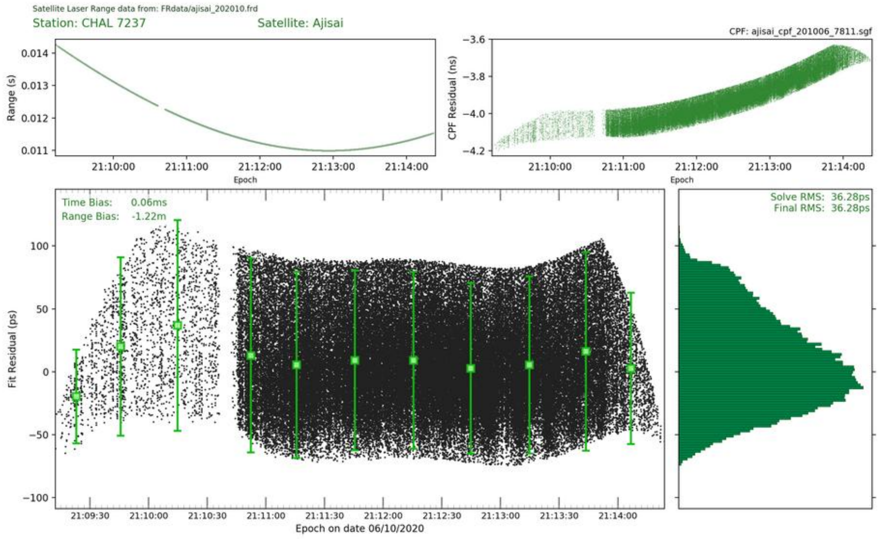
Ajisai

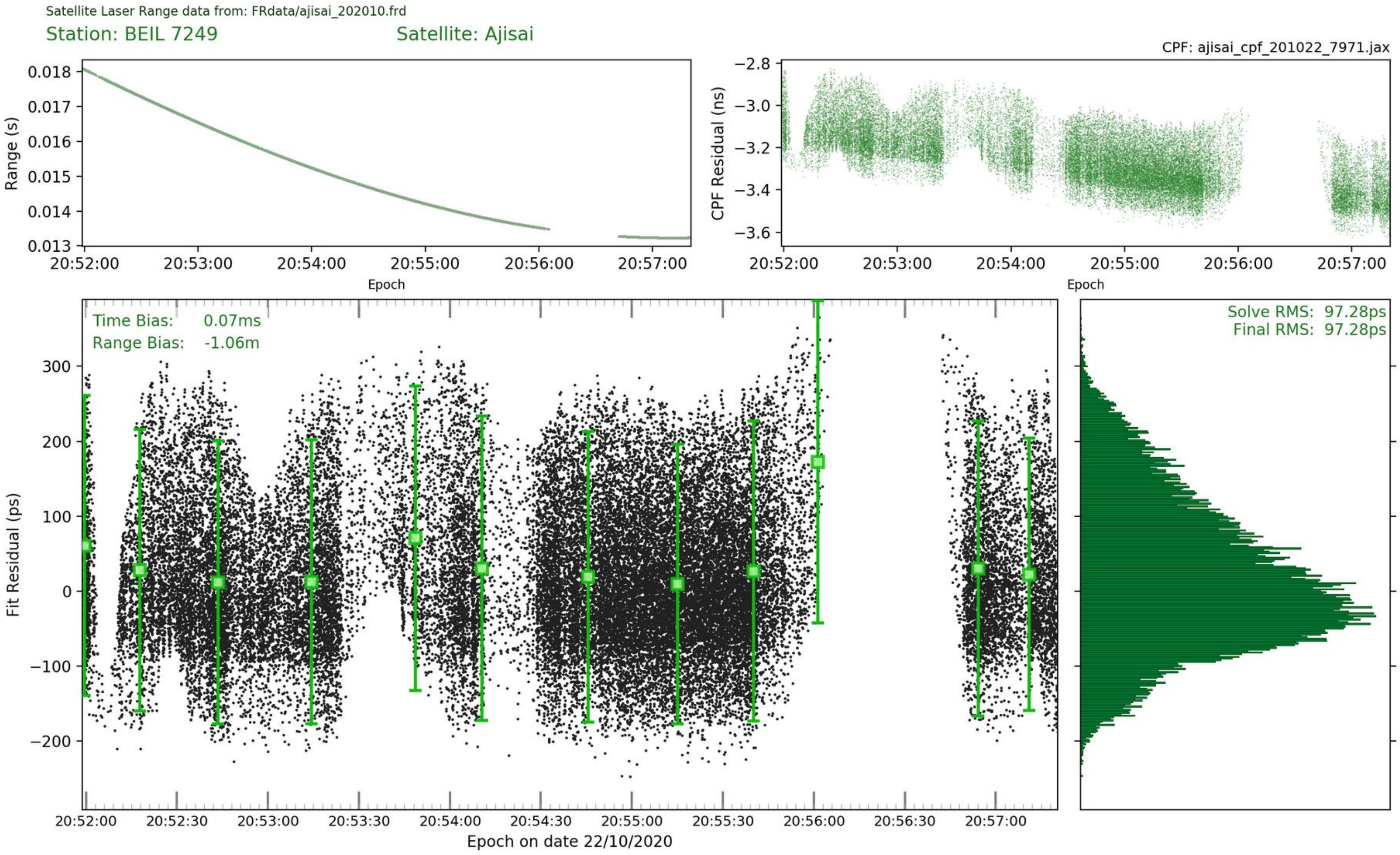
- ChangChun





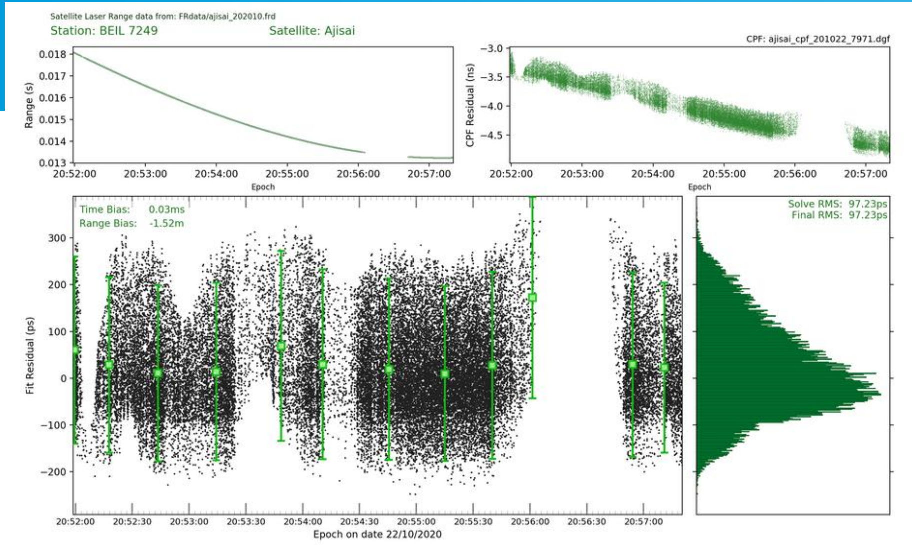


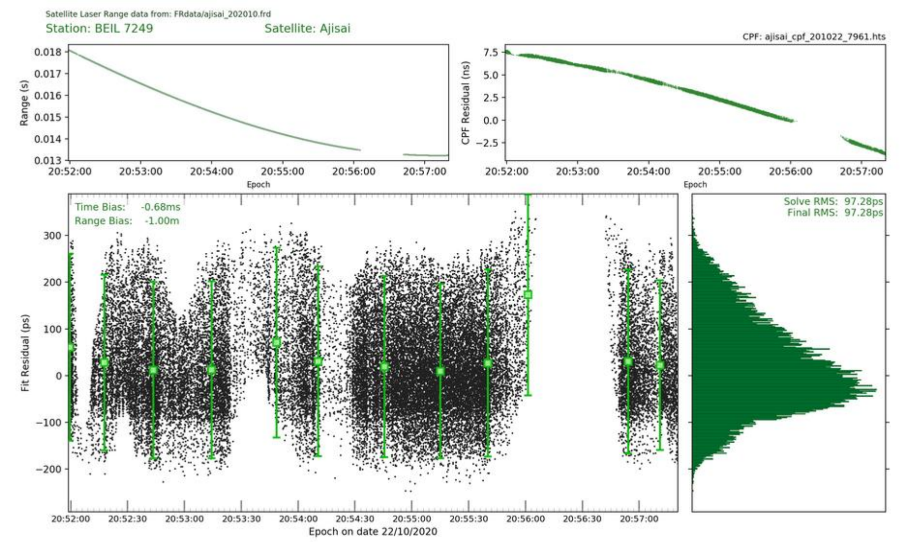


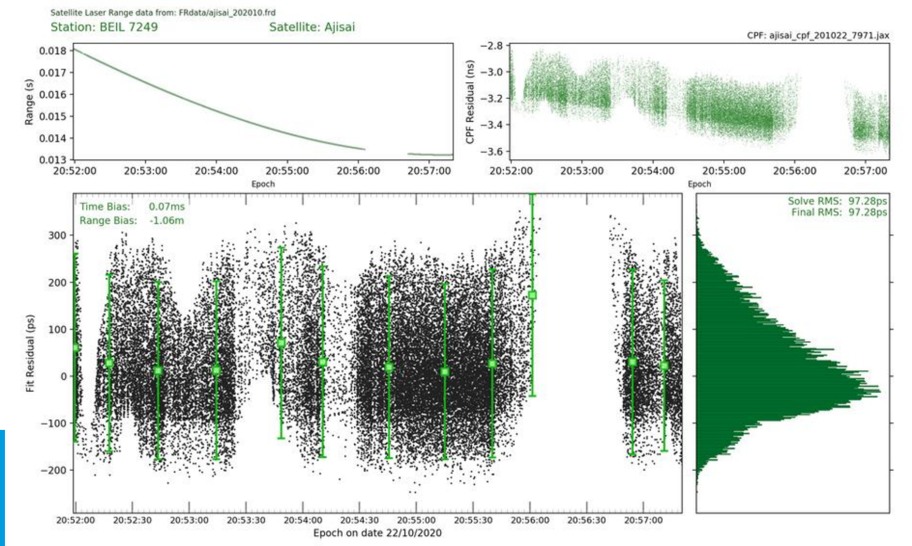


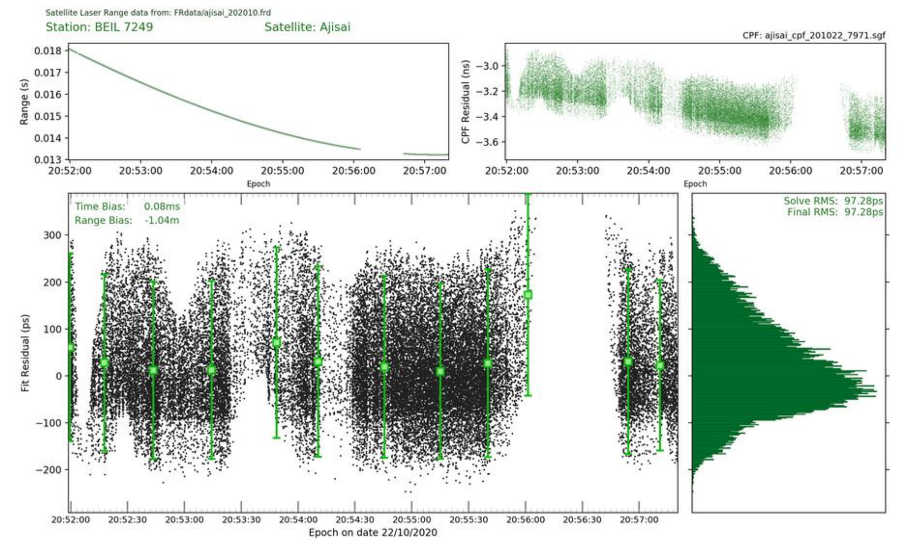
Satellite Laser Range data from: FRdata/ajisai_202010.frd
Station: BEIL 7249
Satellite: Ajisai
CPF: ajisai_cpf_201022_7971.jax
Range (s)
0.018
0.017
0.016
0.015
0.014
0.013
20:52:00
20:53:00
20:54:00
20:55:00
20:56:00
20:57:00
Epoch
CPF Residual (ns)
−2.8
−3.0
−3.2
−3.4
−3.6
Epoch
Time Bias: 0.07ms
Range Bias: -1.06m
Fit Residual (ps)
300
200
100
0
−100
−200
20:52:00
20:52:30
20:53:00
20:53:30
20:54:00
20:54:30
20:55:00
20:55:30
20:56:00
20:56:30
20:57:00
Epoch on date 22/10/2020
Solve RMS: 97.28ps
Final RMS: 97.28ps

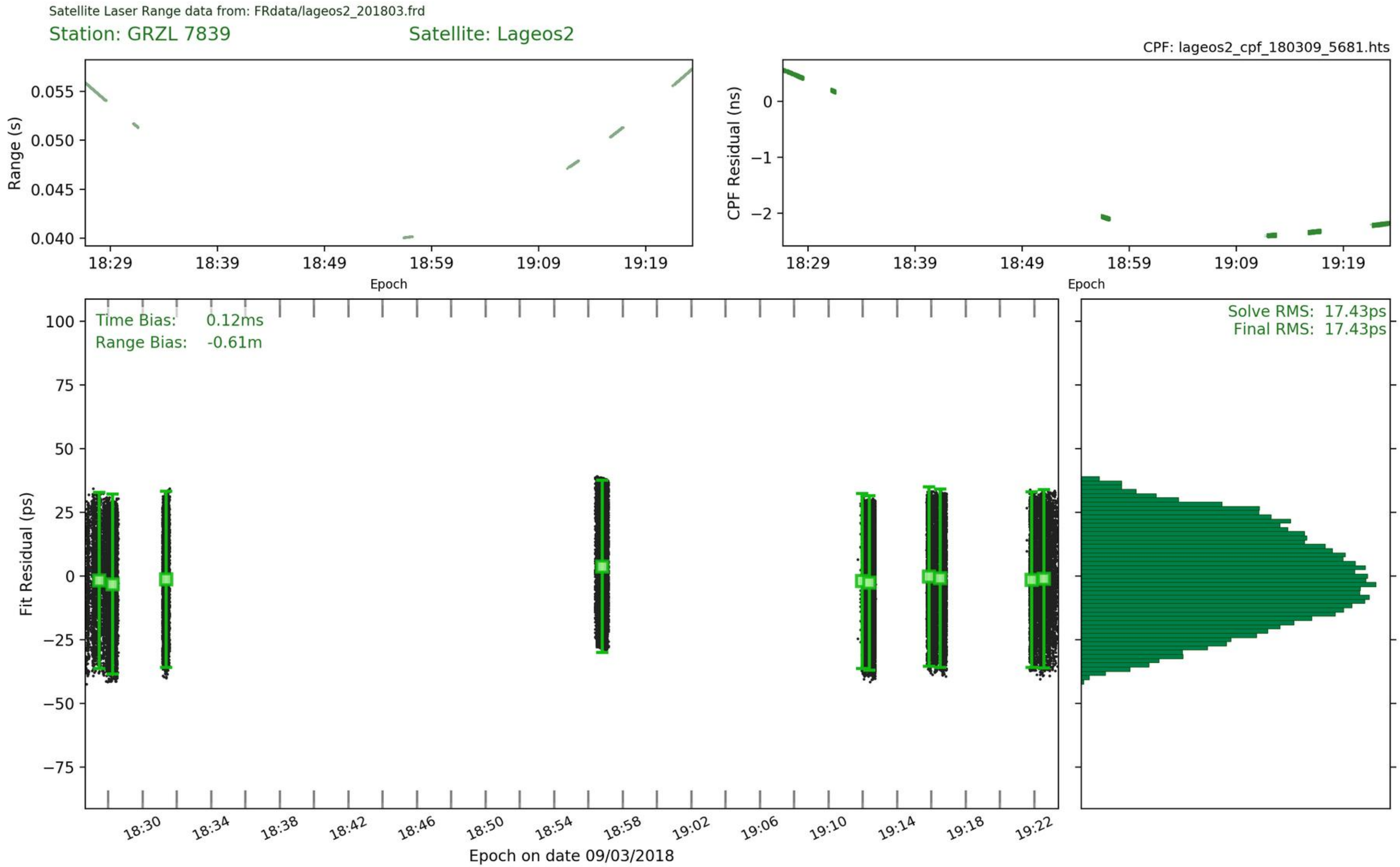
Ajisai
- Beijing



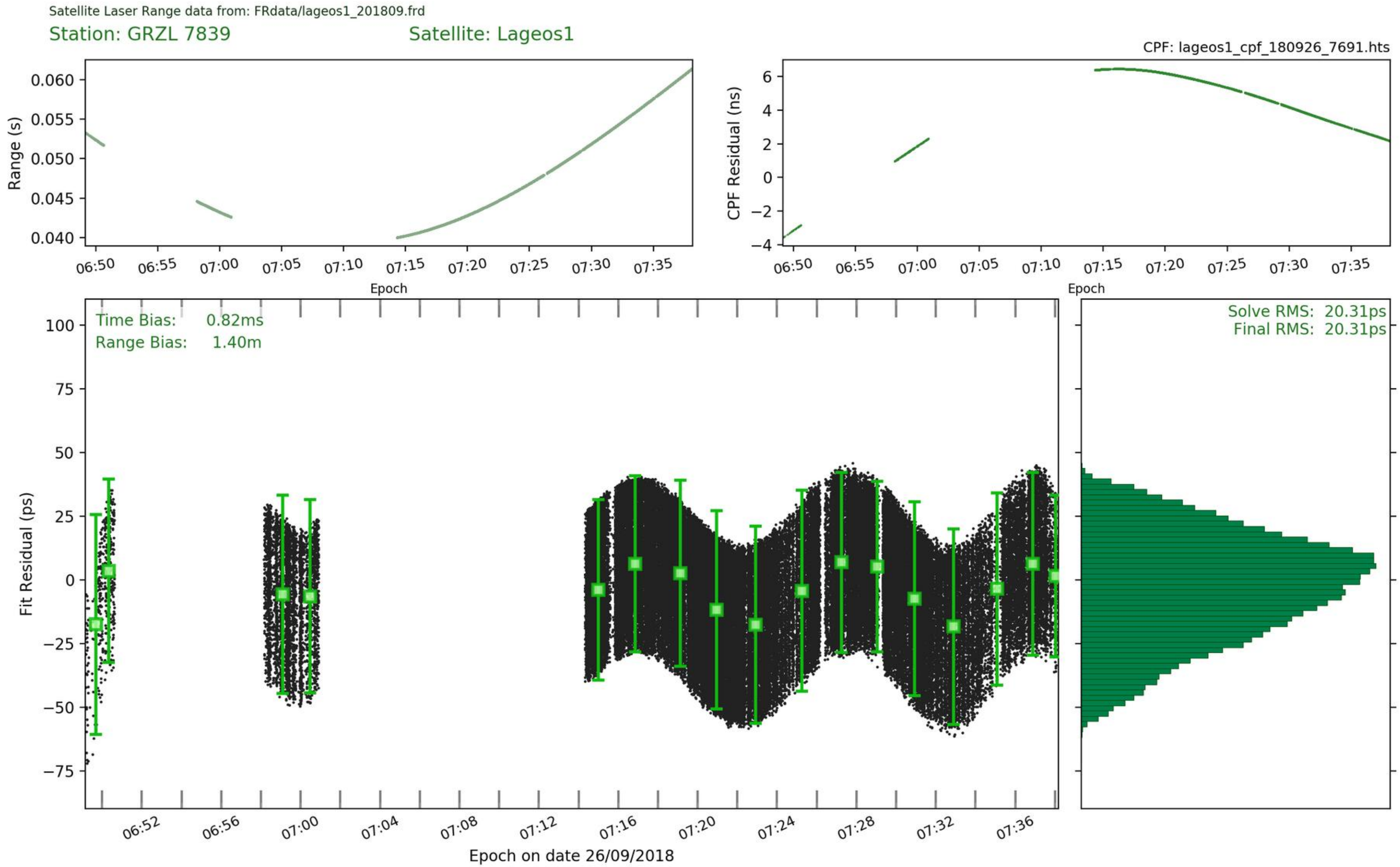








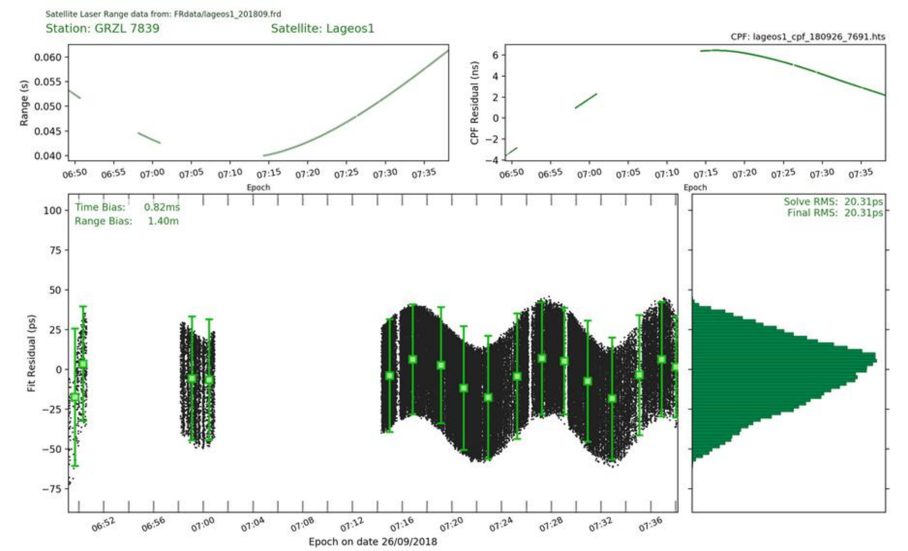
Satellite Laser Range data from: FRdata/lageos2_201803.frd
Station: GRZL 7839
Satellite: Lageos2
CPF: lageos2_cpf_180309_5681.hts
Range (s)
0.055
0.050
0.045
0.040
18:29
18:39
18:49
18:59
19:09
19:19
Epoch
CPF Residual (ns)
0
−1
−2
Epoch
Time Bias: 0.12ms
Range Bias: -0.61m
Fit Residual (ps)
100
75
50
25
0
−25
−50
−75
18:30
18:34
18:38
18:42
18:46
18:50
18:54
18:58
19:02
19:06
19:10
19:14
19:18
19:22
Epoch on date 09/03/2018
Solve RMS: 17.43ps
Final RMS: 17.43ps

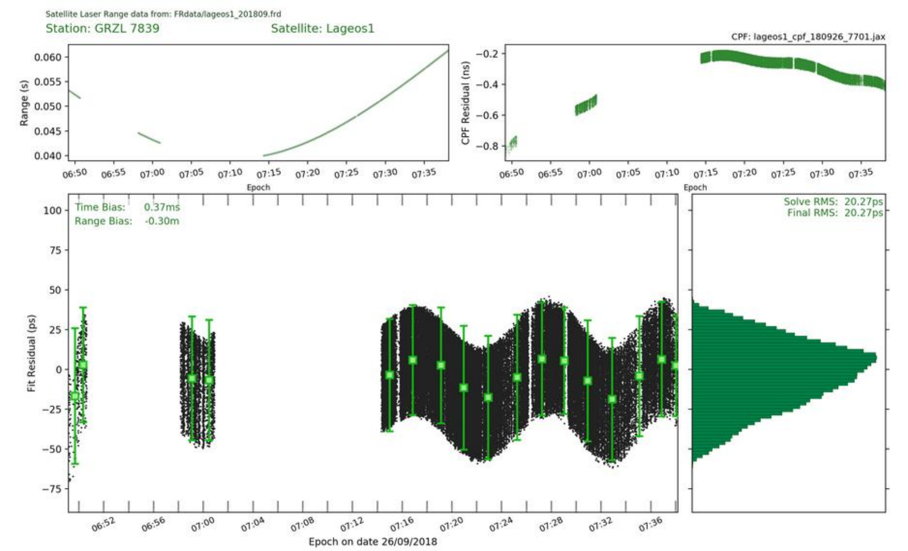


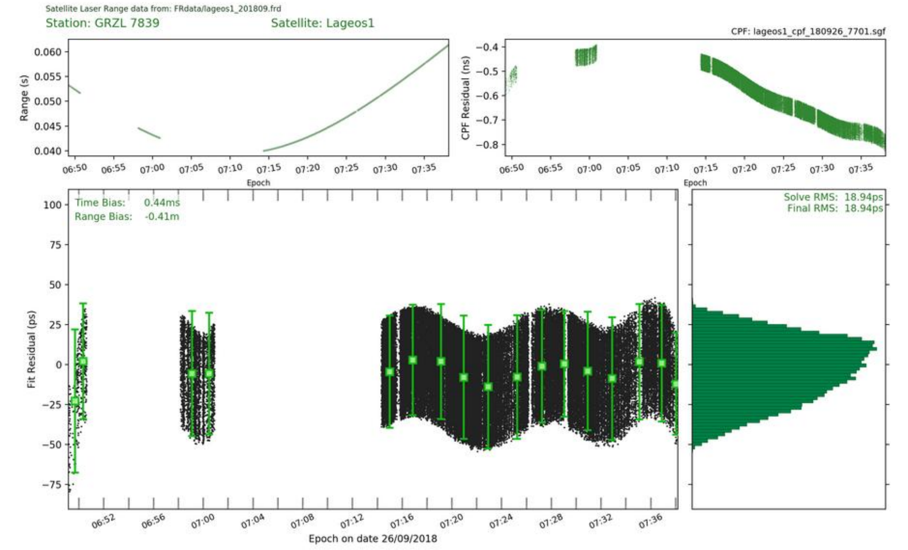
Satellite Laser Range data from: FRdata/lageos1_201809.frd
Station: GRZL 7839
Satellite: Lageos1
CPF: lageos1_cpf_180926_7691.hts
Range (s)
CPF Residual (ns)
Epoch
Epoch
Time Bias: 0.82ms
Range Bias: 1.40m
Solve RMS: 20.31ps
Final RMS: 20.31ps
Fit Residual (ps)
Epoch on date 26/09/2018

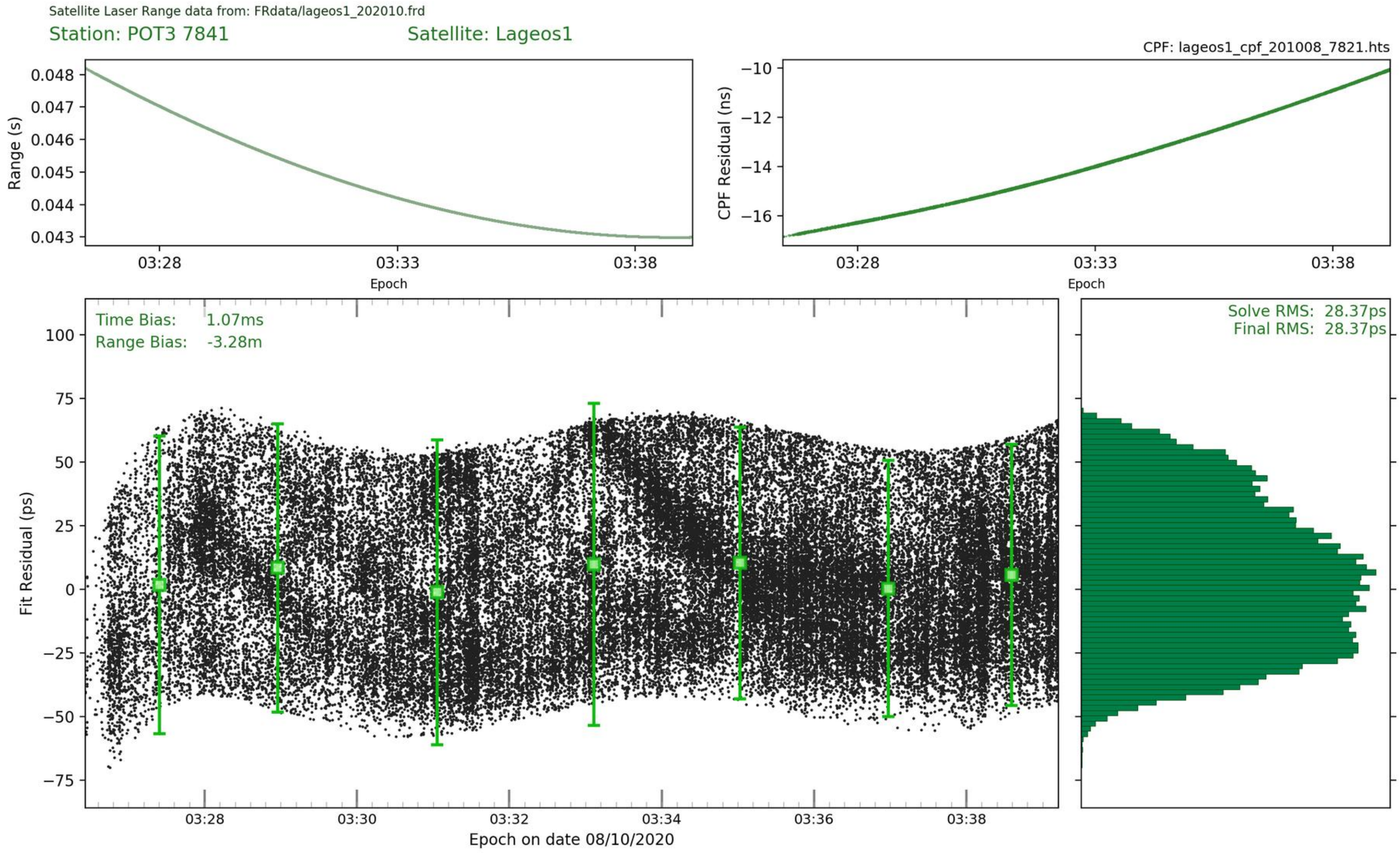
Lageos1

- Graz

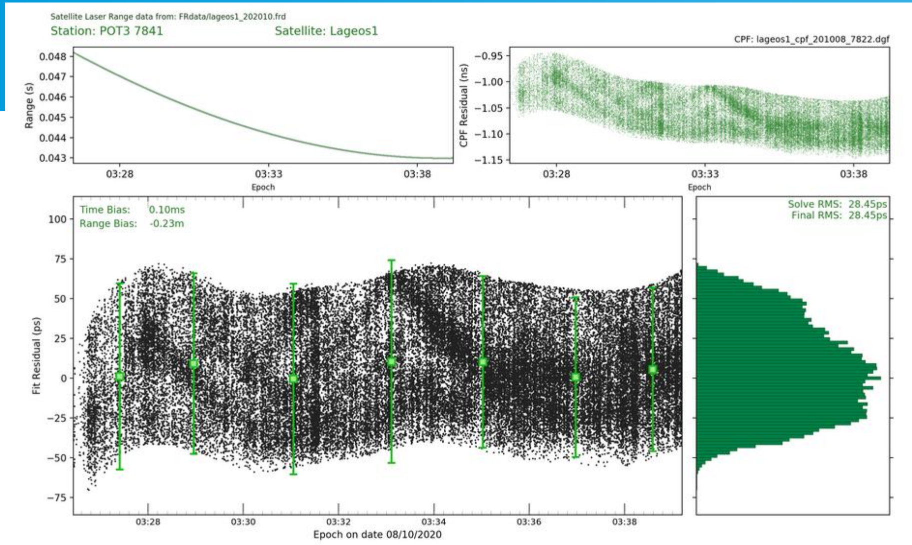


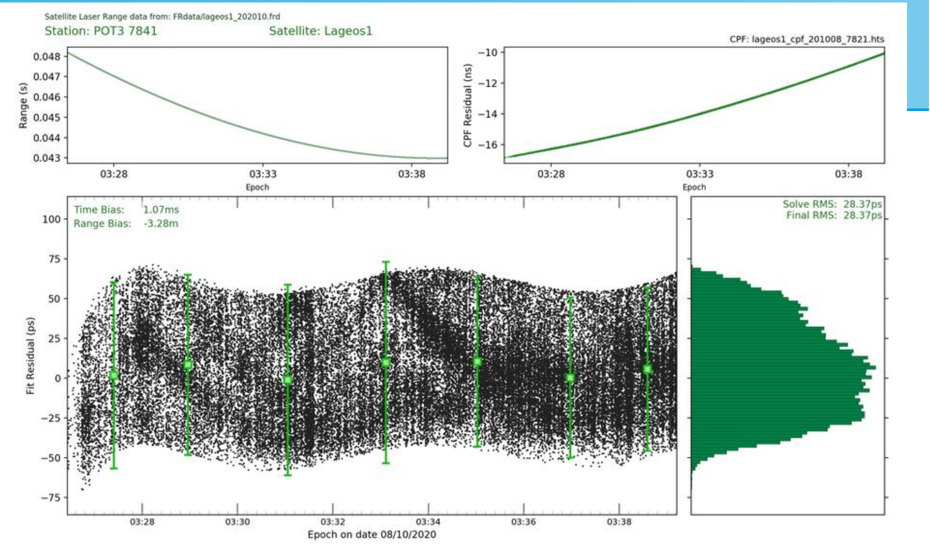


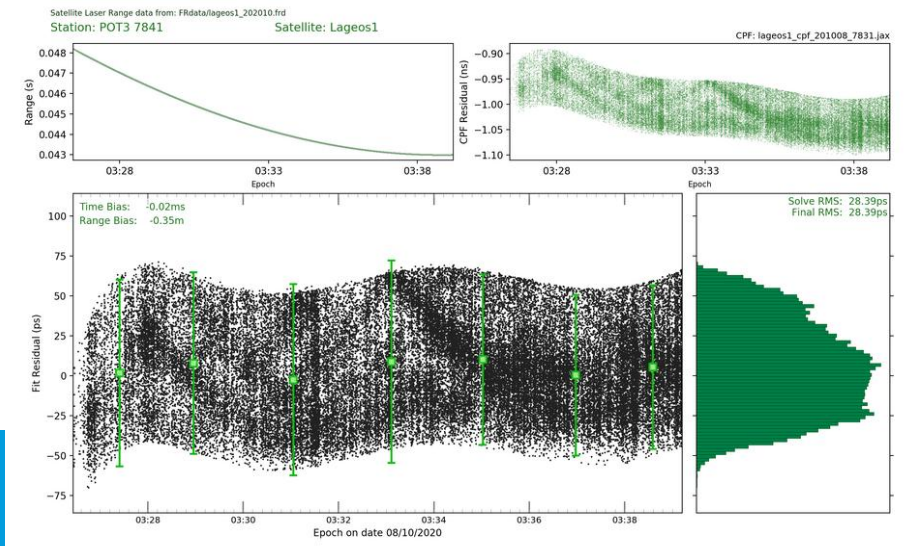


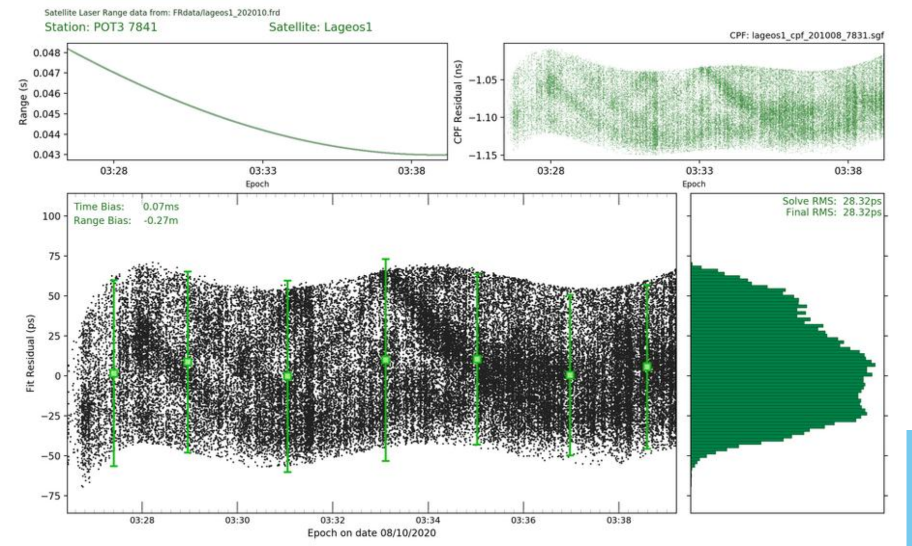

Satellite Laser Range data from: FRdata/lageos1_202010.frd
Station: POT3 7841
Satellite: Lageos1
CPF: lageos1_cpf_201008_7821.hts
Range (s)
Epoch
CPF Residual (ns)
Epoch
Time Bias: 1.07ms
Range Bias: -3.28m
Solve RMS: 28.37ps
Final RMS: 28.37ps
Fit Residual (ps)
Epoch on date 08/10/2020

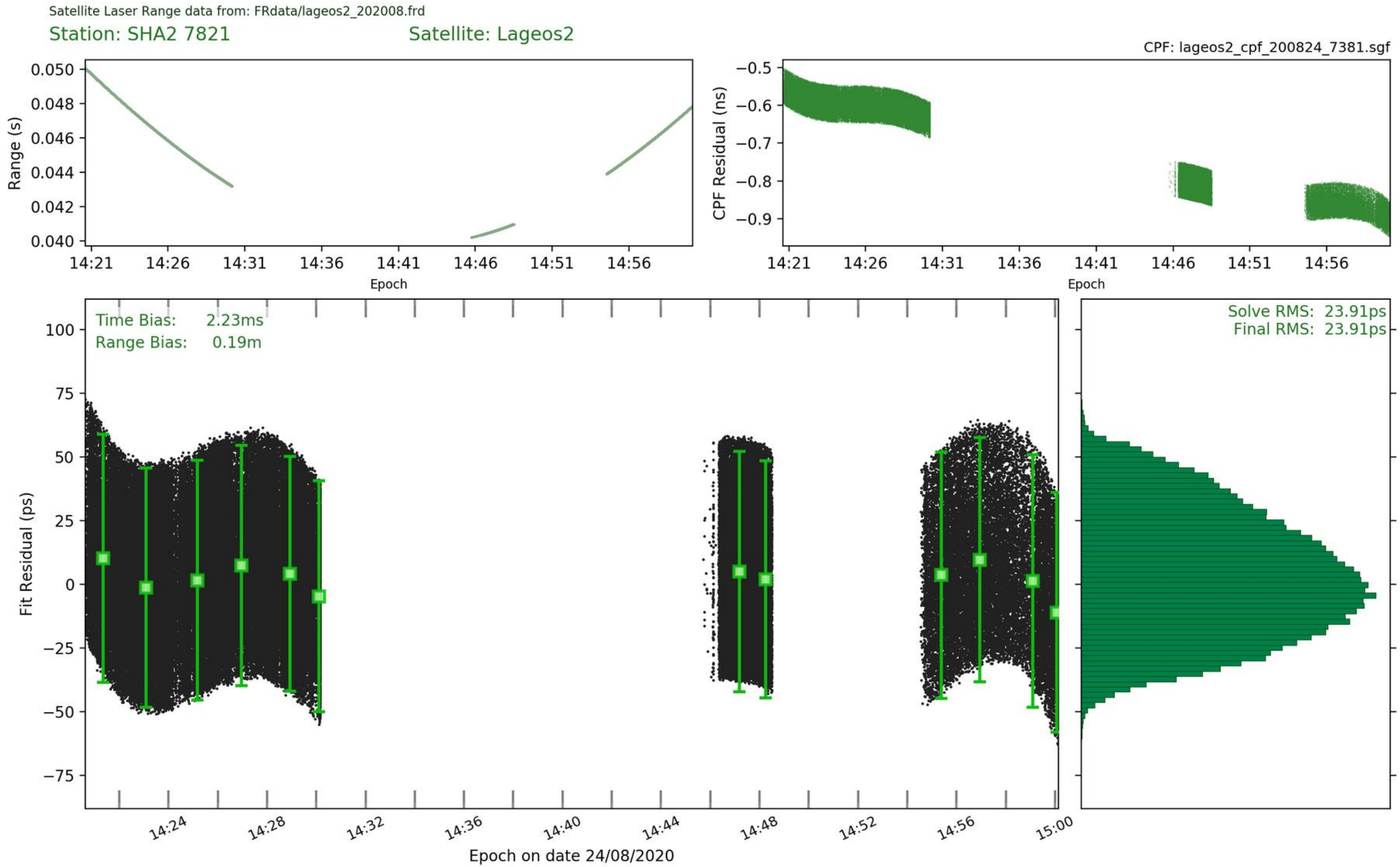
Lageos1 - Potsdam





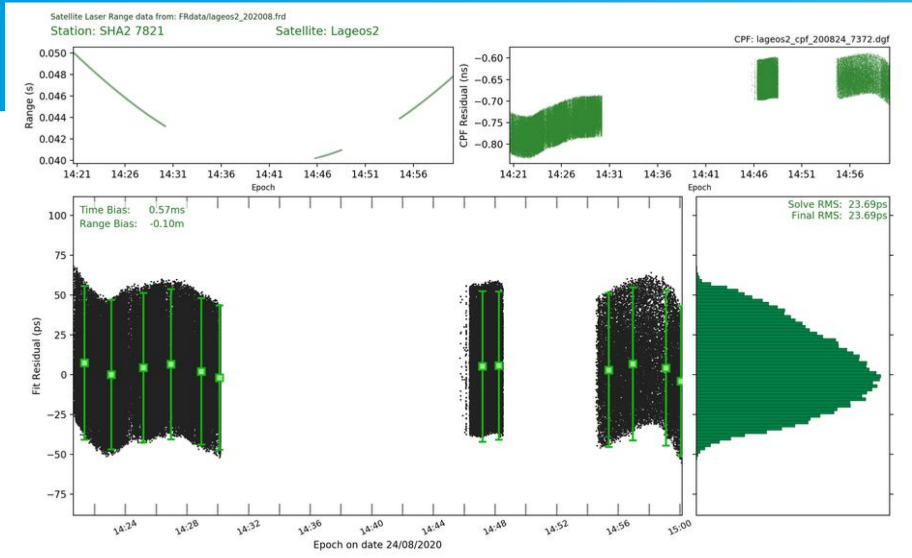


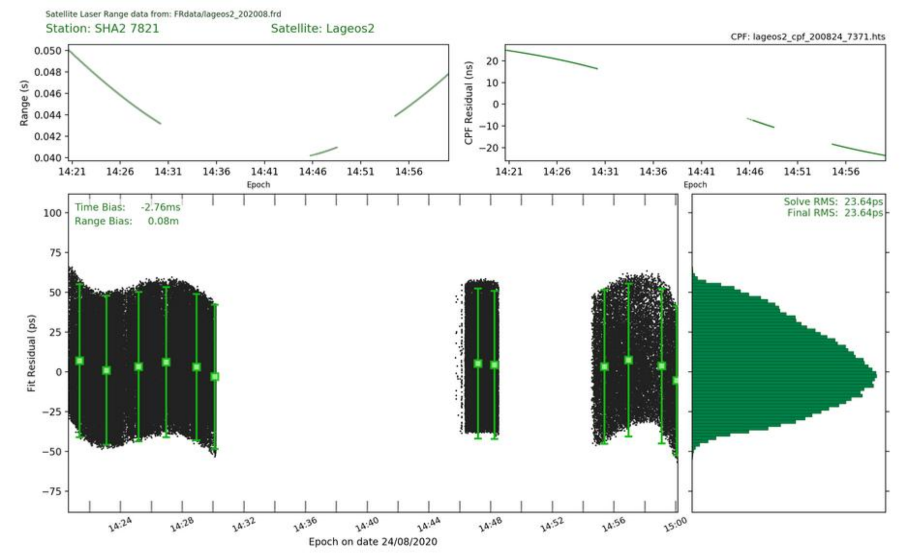


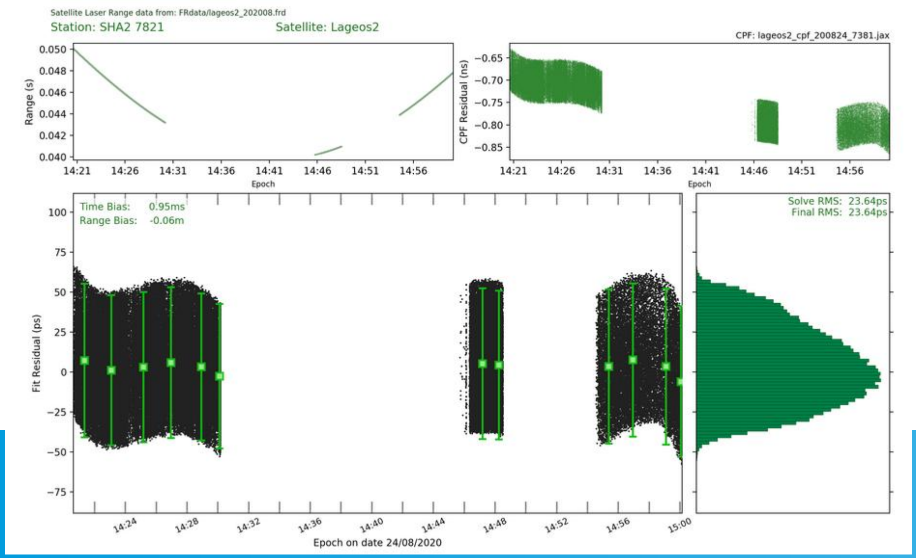


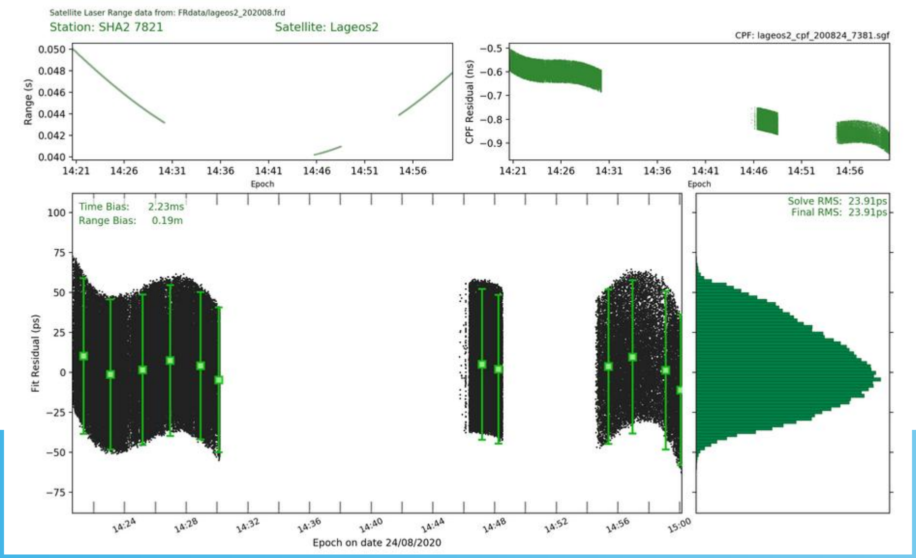
Satellite Laser Range data from: FRdata/lageos2_202008.frd
Station: SHA2 7821
Satellite: Lageos2
CPF: lageos2_cpf_200824_7381.sgf
Range (s)
Epoch
CPF Residual (ns)
Epoch
Time Bias: 2.23ms
Range Bias: 0.19m
Fit Residual (ps)
Epoch on date 24/08/2020
Solve RMS: 23.91ps
Final RMS: 23.91ps

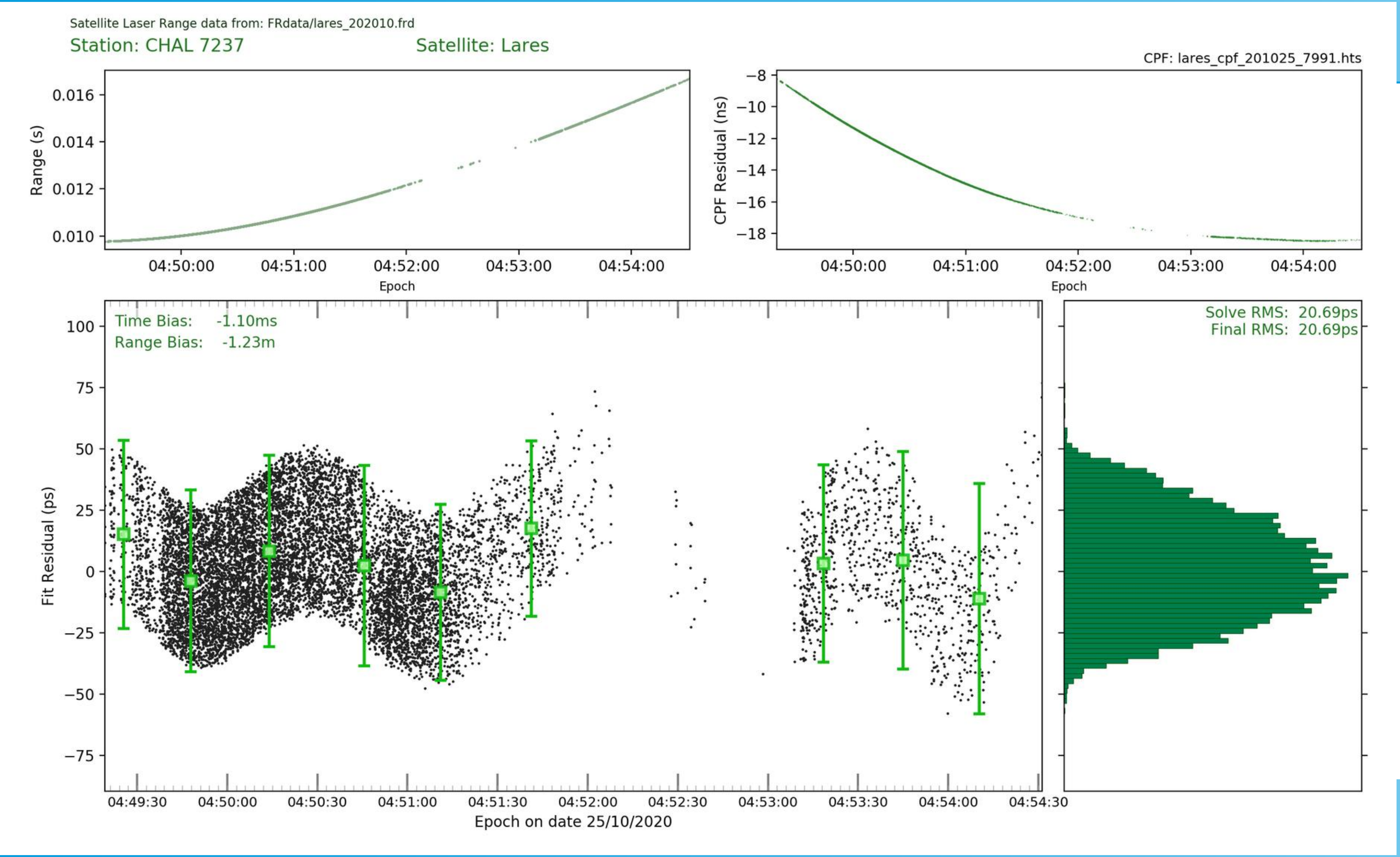
Lageos2
- Shanghai







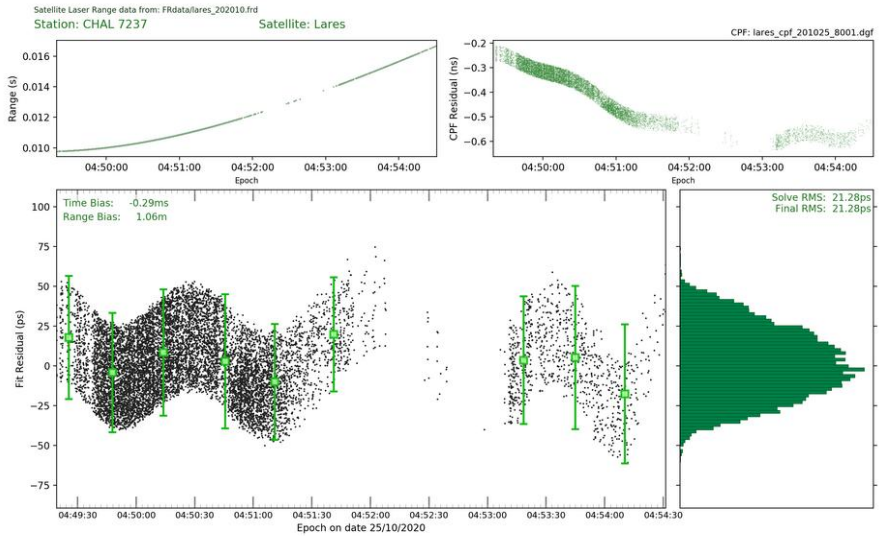


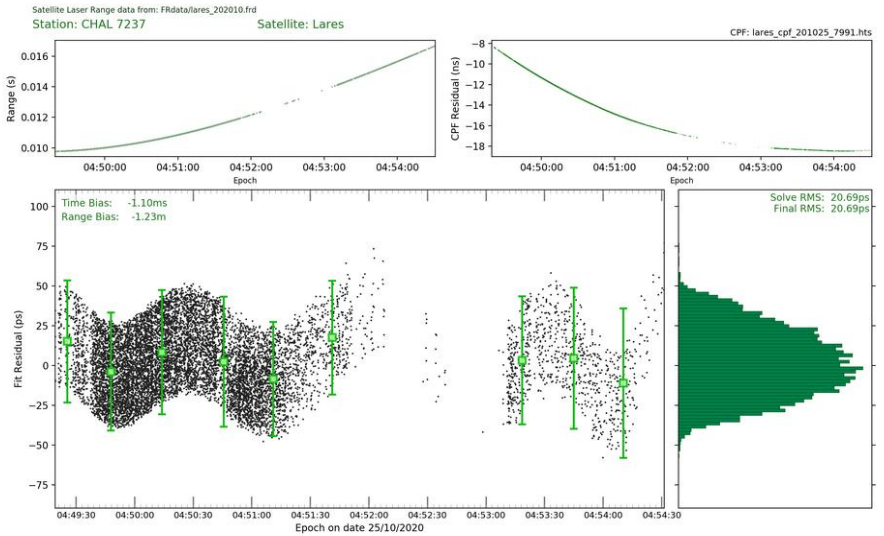


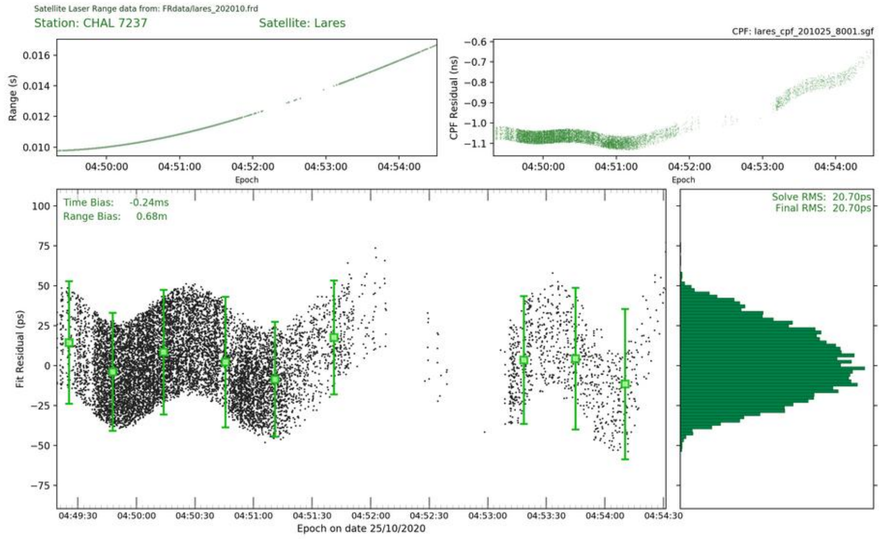
Satellite Laser Range data from: FRdata/lares_202010.frd
Station: CHAL 7237
Satellite: Lares
CPF: lares_cpf_201025_7991.hts
Range (s)
0.016
0.014
0.012
0.010
04:50:00
04:51:00
04:52:00
04:53:00
04:54:00
Epoch
CPF Residual (ns)
−8
−10
−12
−14
−16
−18
Time Bias: -1.10ms
Range Bias: -1.23m
Solve RMS: 20.69ps
Final RMS: 20.69ps
Fit Residual (ps)
100
75
50
25
0
−25
−50
−75
04:49:30
04:50:30
04:51:30
04:52:30
04:53:30
04:54:30
Epoch on date 25/10/2020

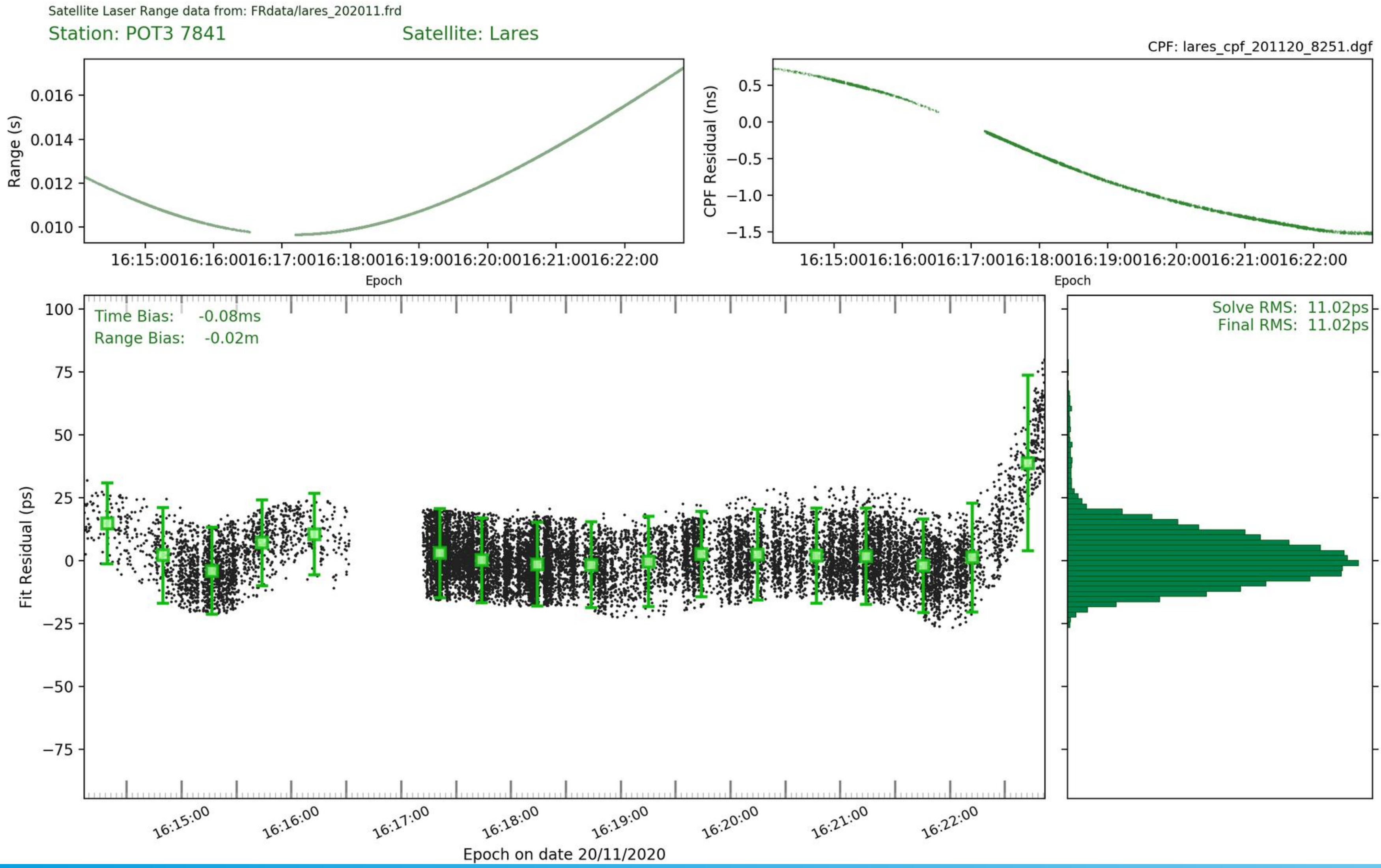
Lares

- Changchun



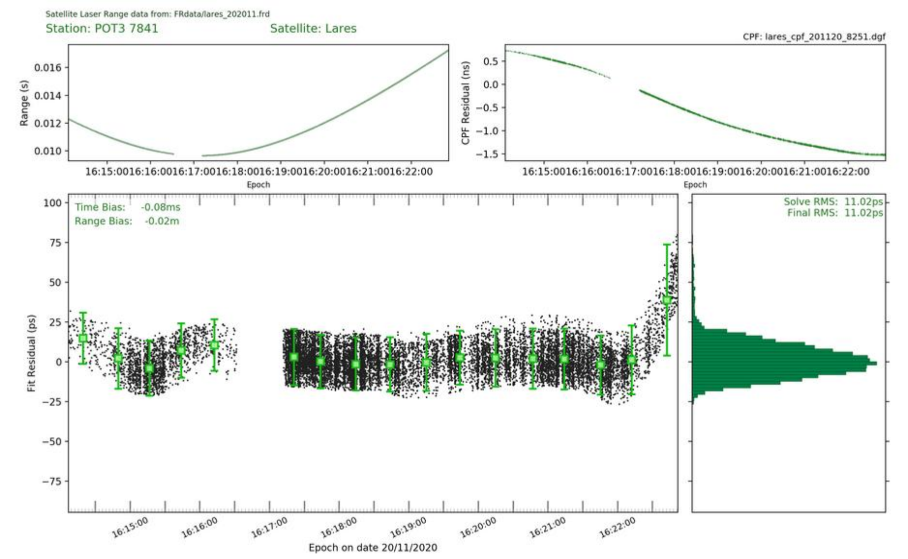


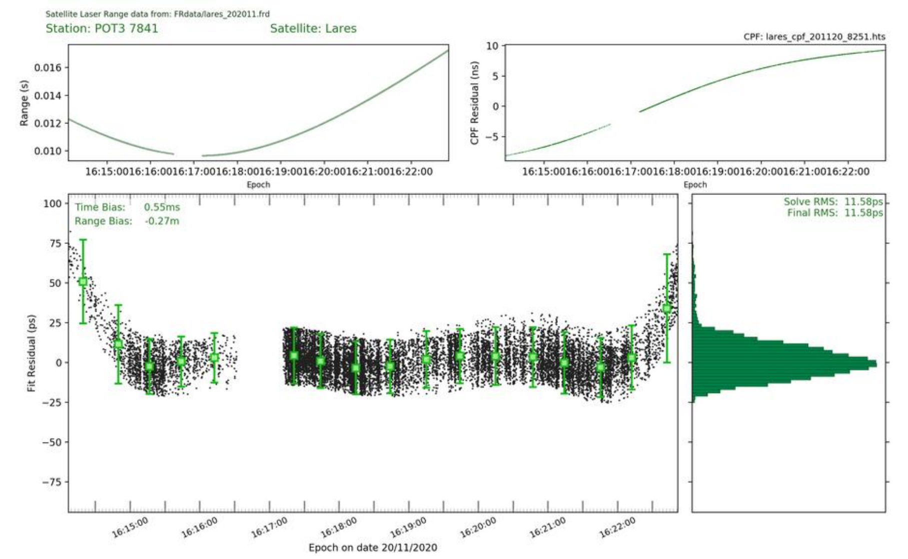


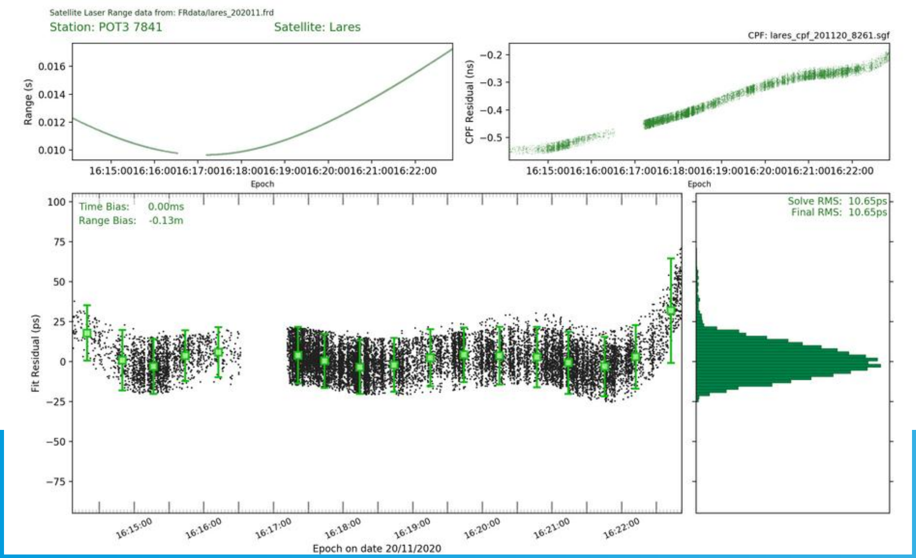

Satellite Laser Range data from: FRdata/lares_202011.frd
Station: POT3 7841
Satellite: Lares
CPF: lares_cpf_201120_8251.dgf
Range (s)
Epoch
CPF Residual (ns)
Epoch
Time Bias: -0.08ms
Range Bias: -0.02m
Fit Residual (ps)
Solve RMS: 11.02ps
Final RMS: 11.02ps
Epoch on date 20/11/2020

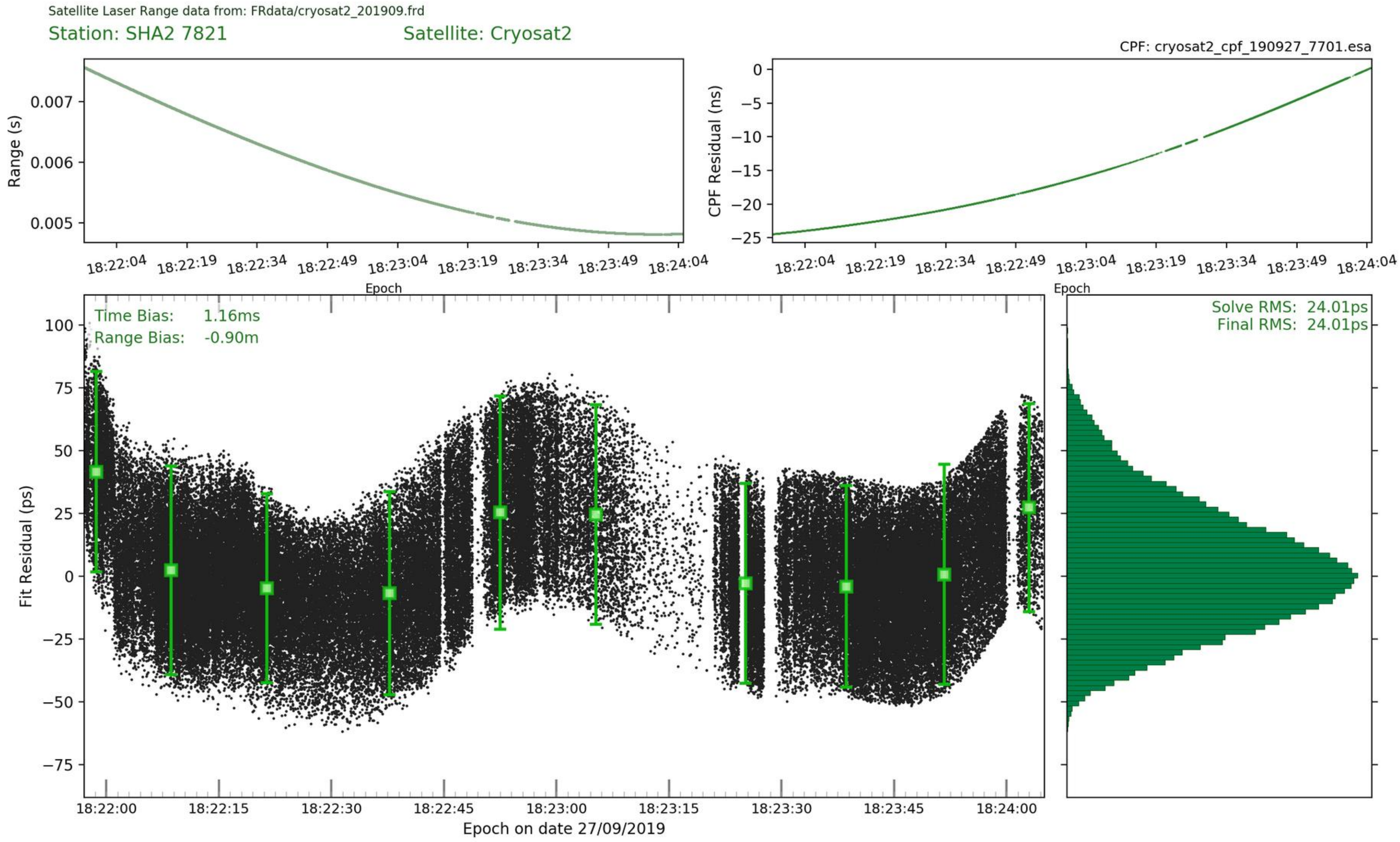
Lares

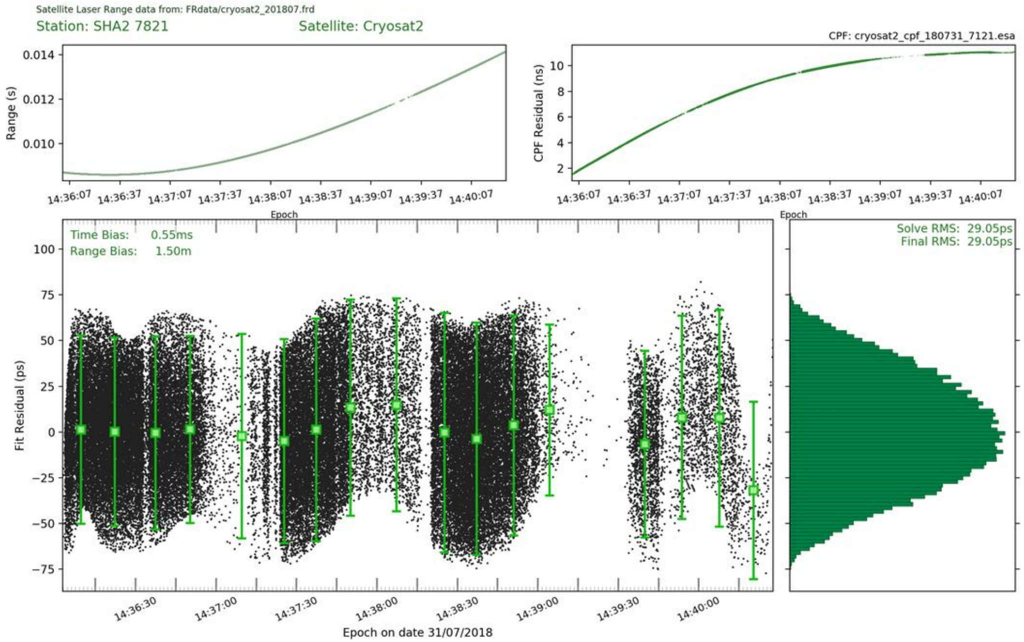
- Potsdam



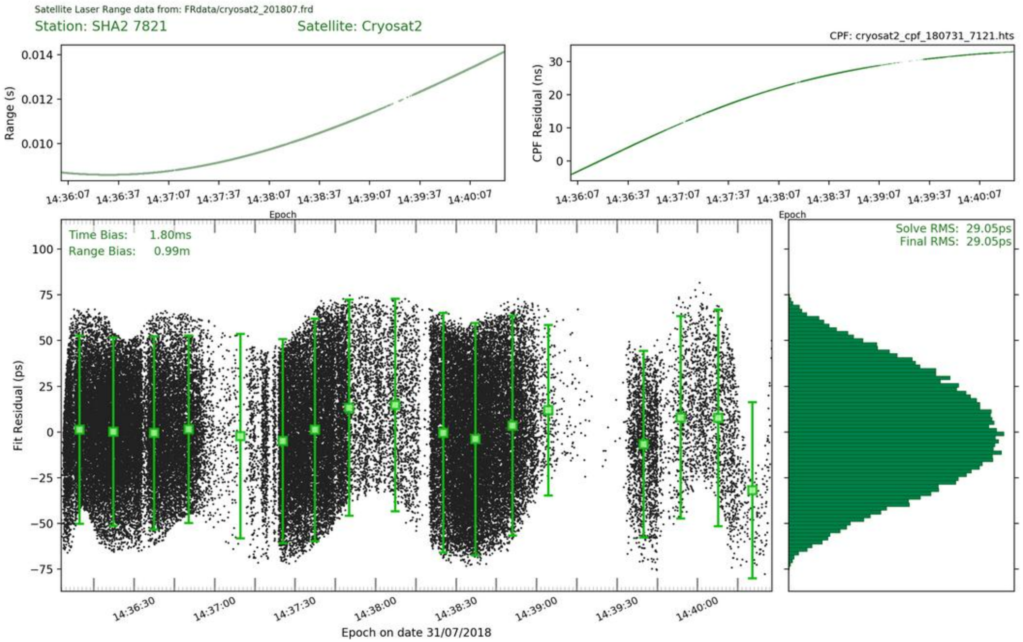




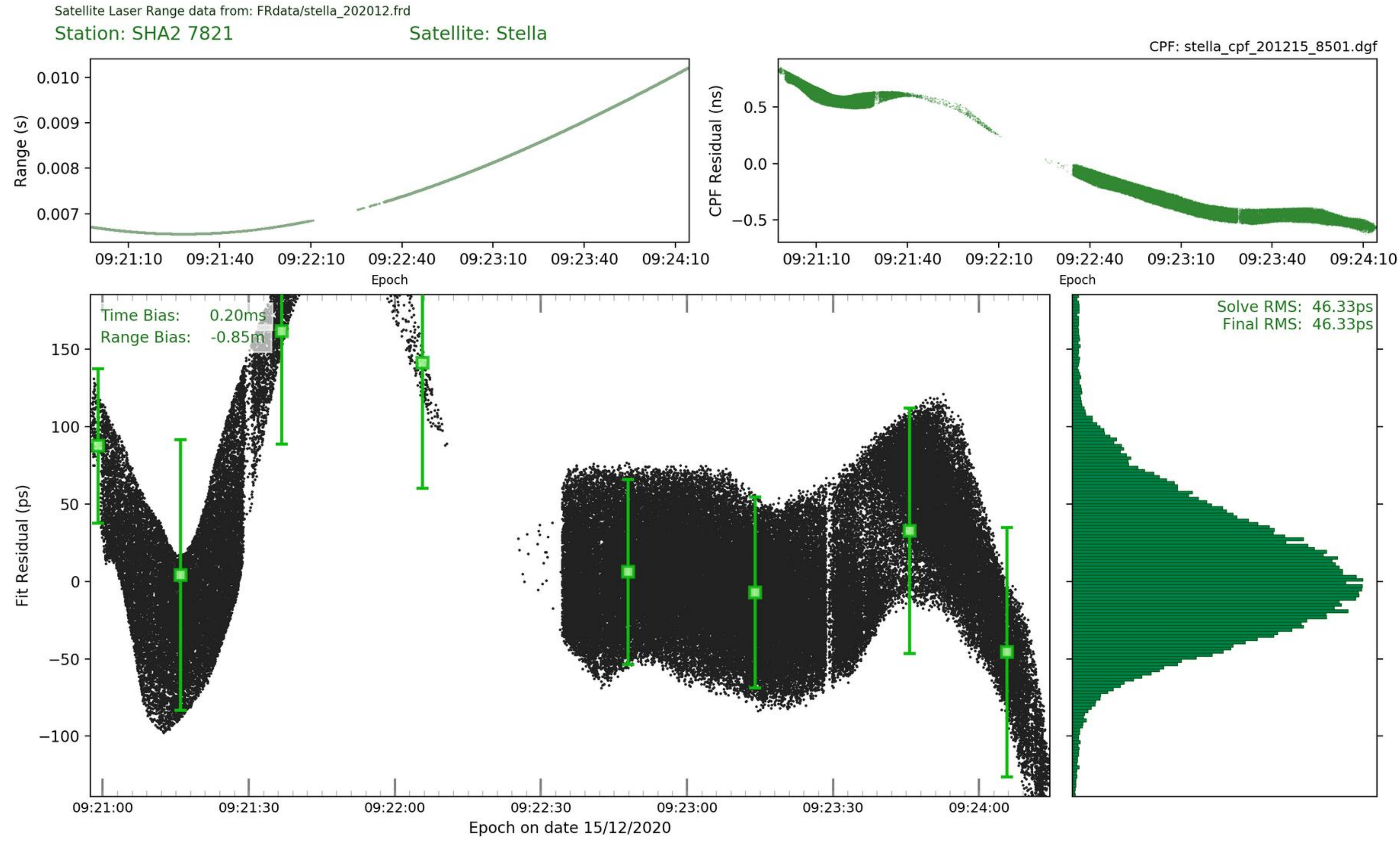

Satellite Laser Range data from: FRdata/cryosat2_201909.frd
Station: SHA2 7821
Satellite: Cryosat2
CPF: cryosat2_cpf_190927_7701.esa
Range (s)
0.007
0.006
0.005
CPF Residual (ns)
0
−5
−10
−15
−20
−25
18:22:04
18:22:19
18:22:34
18:22:49
18:23:04
18:23:19
18:23:34
18:23:49
18:24:04
Epoch
Time Bias: 1.16ms
Range Bias: -0.90m
Solve RMS: 24.01ps
Final RMS: 24.01ps
Fit Residual (ps)
100
75
50
25
0
−25
−50
−75
18:22:00
18:22:15
18:22:30
18:22:45
18:23:00
18:23:15
18:23:30
18:23:45
18:24:00
Epoch on date 27/09/2019



Satellite Laser Range data from: FRdata/cryosat2_201807.frd
Station: SHA2 7821
Satellite: Cryosat2
CPF: cryosat2_cpf_180731_7121.esa
Range (s)
CPF Residual (ns)
Epoch
Time Bias: 0.55ms
Range Bias: 1.50m
Solve RMS: 29.05ps
Final RMS: 29.05ps
Fit Residual (ps)
Epoch on date 31/07/2018



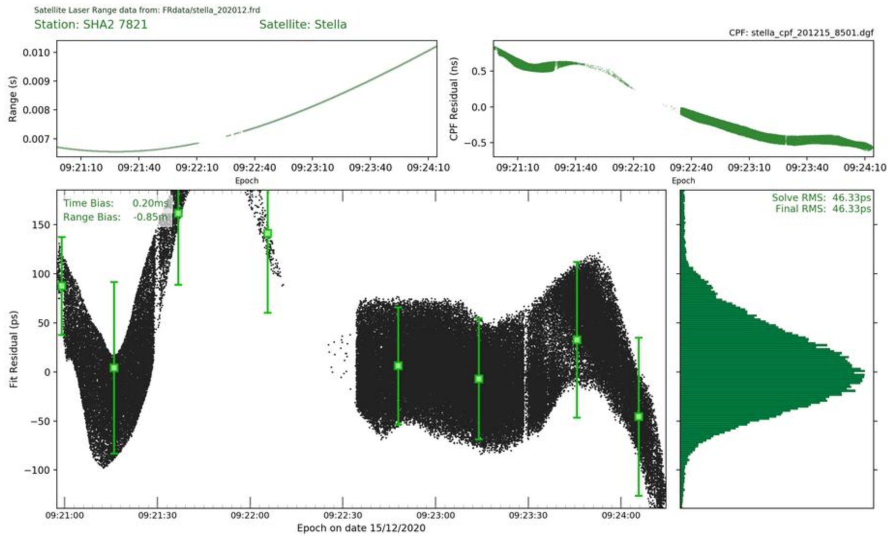
Satellite Laser Range data from: FRdata/cryosat2_201807.frd
Station: SHA2 7821
Satellite: Cryosat2
CPF: cryosat2_cpf_180731_7121.hts
Range (s)
CPF Residual (ns)
Epoch
Time Bias: 1.80ms
Range Bias: 0.99m
Solve RMS: 29.05ps
Final RMS: 29.05ps
Fit Residual (ps)
Epoch on date 31/07/2018

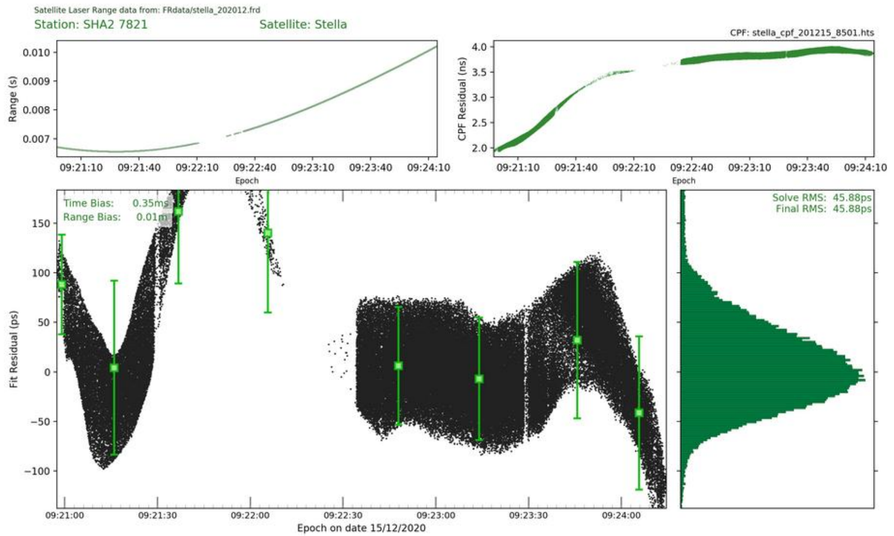


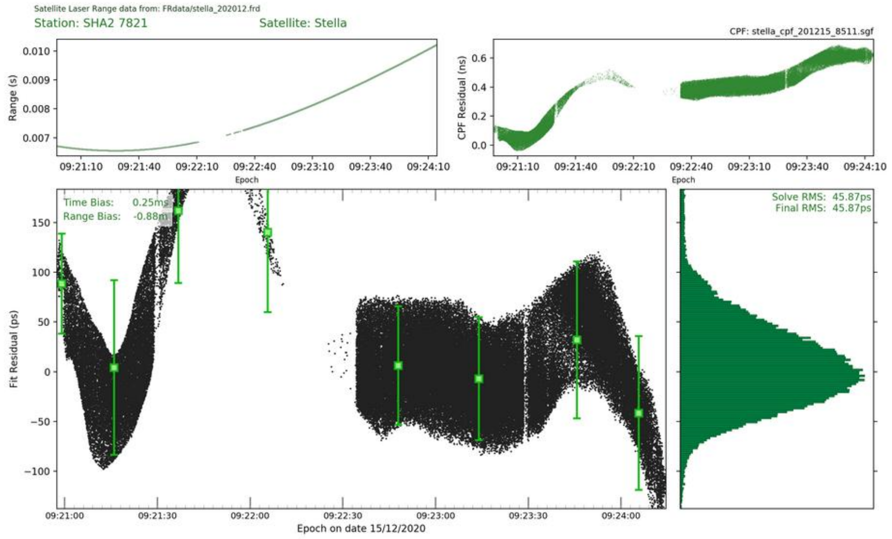
Satellite Laser Range data from: FRdata/stella_202012.frd
Station: SHA2 7821
Satellite: Stella
CPF: stella_cpf_201215_8501.dgf
Range (s)
0.010
0.009
0.008
0.007
09:21:10
09:21:40
09:22:10
09:22:40
09:23:10
09:23:40
09:24:10
Epoch
CPF Residual (ns)
0.5
0.0
−0.5
Epoch
Time Bias: 0.20ms
Range Bias: -0.85m
Fit Residual (ps)
150
100
50
0
−50
−100
09:21:00
09:21:30
09:22:00
09:22:30
09:23:00
09:23:30
09:24:00
Epoch on date 15/12/2020
Solve RMS: 46.33ps
Final RMS: 46.33ps

Stella

- Shanghai

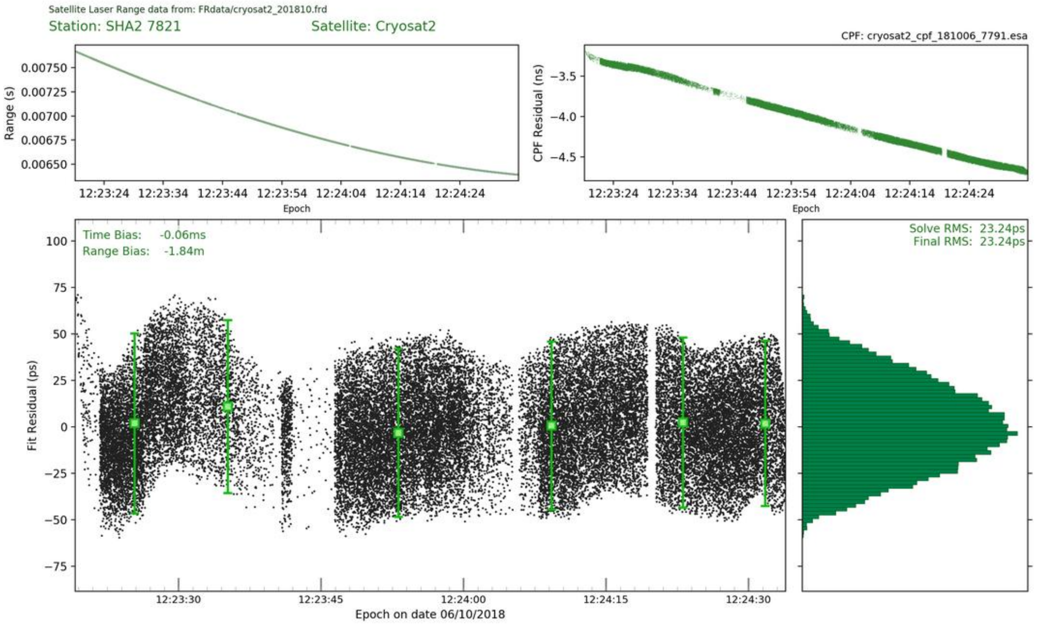


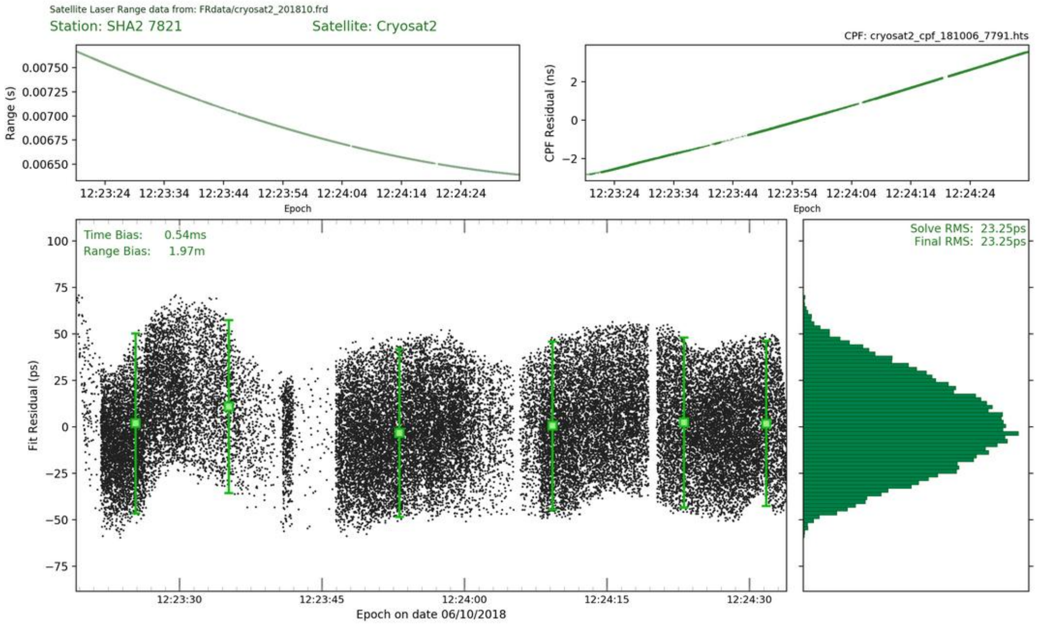




Cryosat2

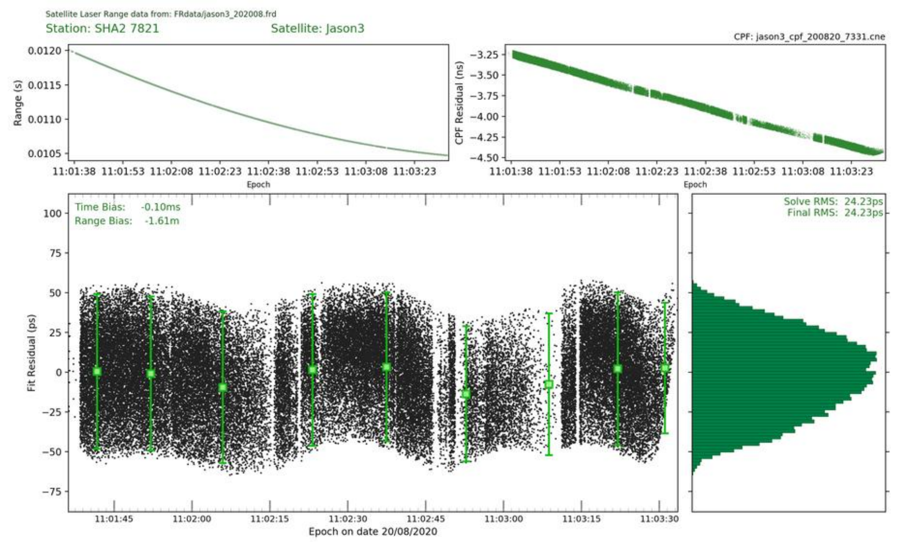
- Shanghai

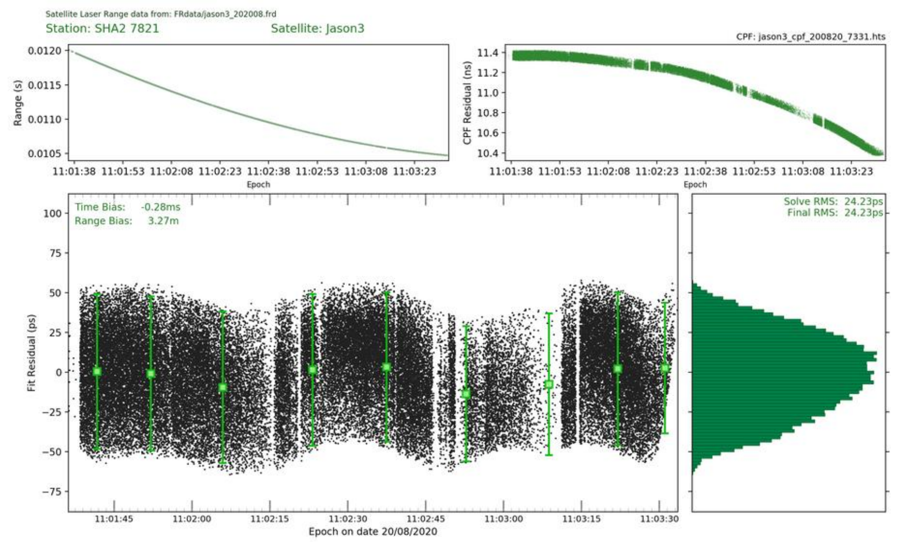


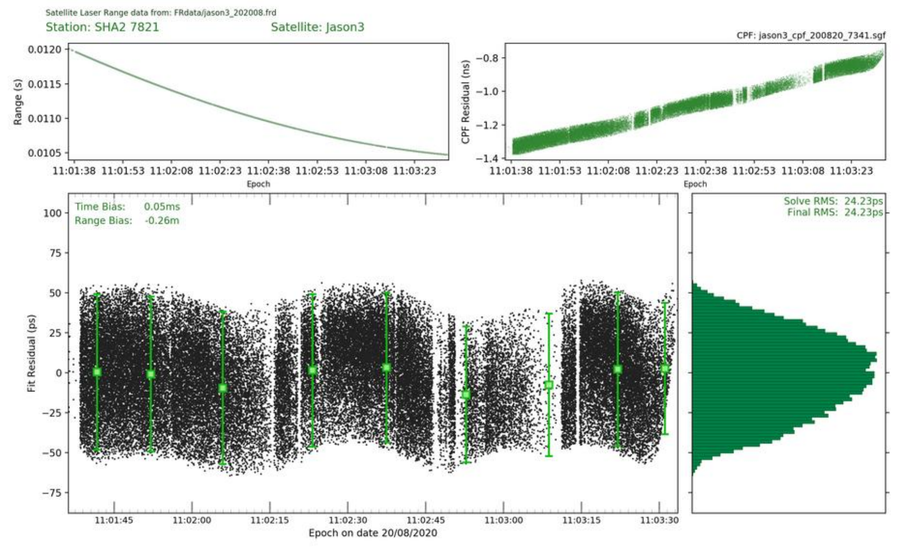


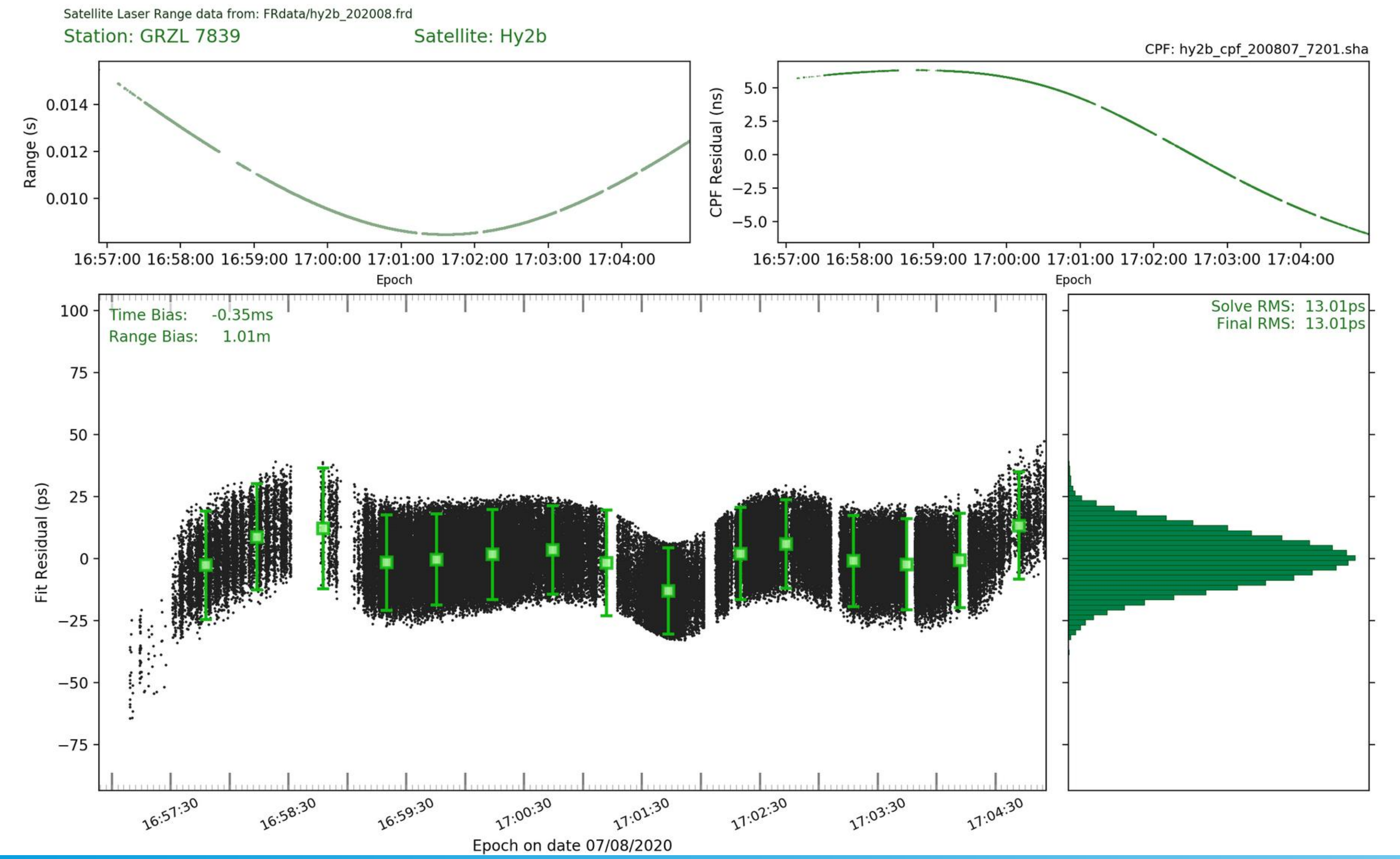
Jason3

- Shanghai

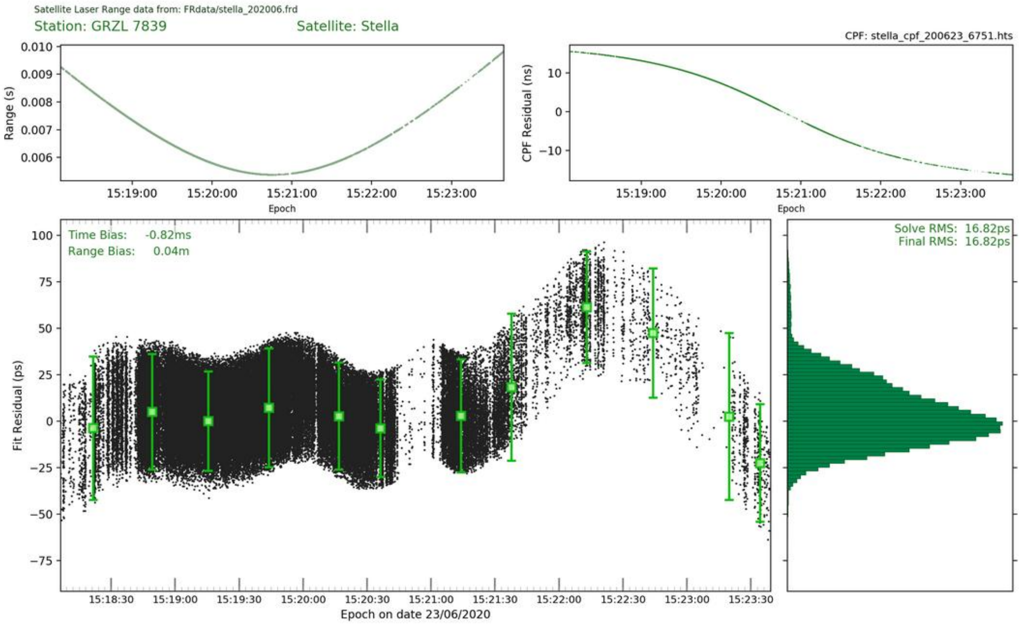




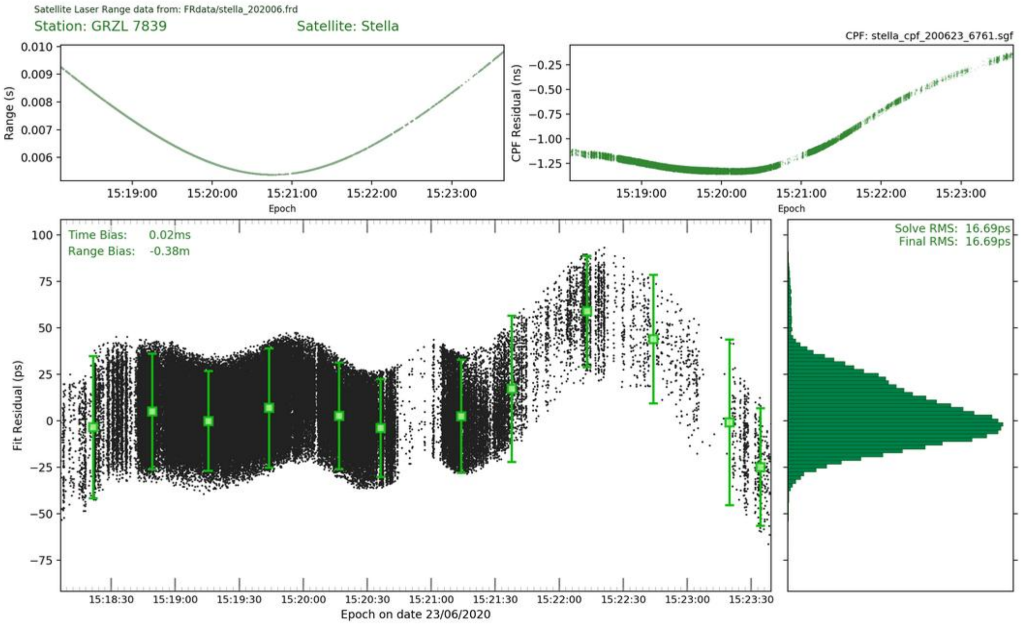



Satellite Laser Range data from: FRdata/hy2b_202008.frd
Station: GRZL 7839
Satellite: Hy2b
CPF: hy2b_cpf_200807_7201.sha
Range (s)
Epoch
CPF Residual (ns)
Epoch
Time Bias: -0.35ms
Range Bias: 1.01m
Fit Residual (ps)
Epoch on date 07/08/2020
Solve RMS: 13.01ps
Final RMS: 13.01ps

Stella
- Graz



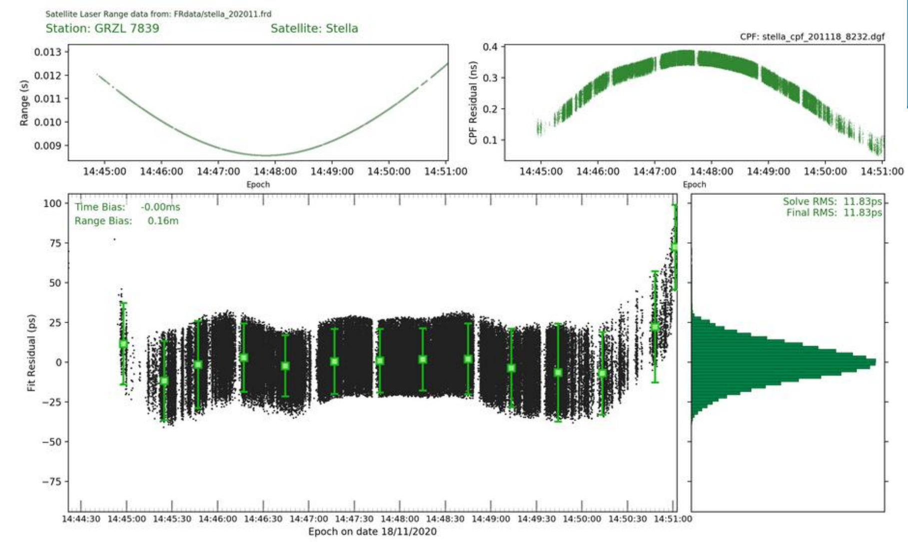
Satellite Laser Range data from: FRdata/stella_202006.frd
Station: GRZL 7839
Satellite: Stella
CPF: stella_cpf_200623_6751.hts
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.82ms
Range Bias: 0.04m
Solve RMS: 16.82ps
Final RMS: 16.82ps
Fit Residual (ps)
Epoch on date 23/06/2020



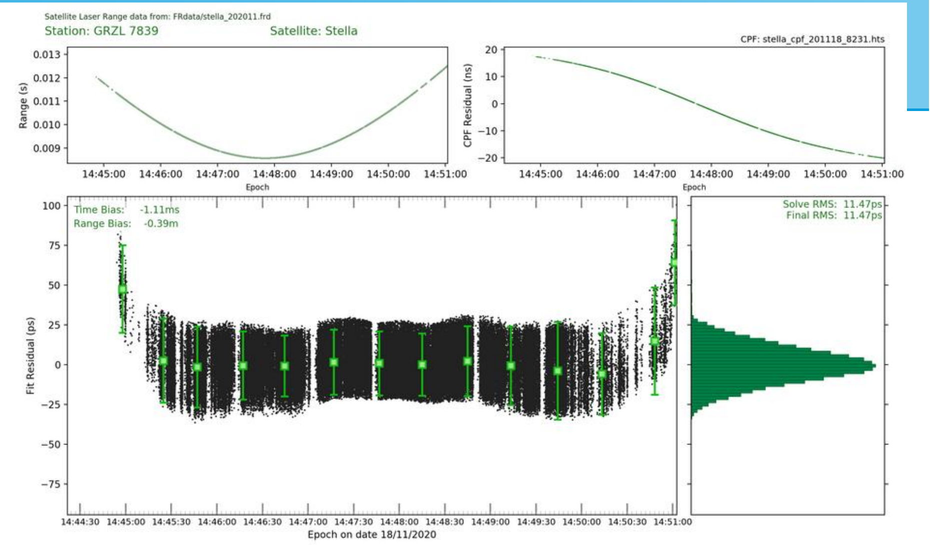
Satellite Laser Range data from: FRdata/stella_202006.frd
Station: GRZL 7839
Satellite: Stella
CPF: stella_cpf_200623_6761.sgf
Range (s)
CPF Residual (ns)
Epoch
Time Bias: 0.02ms
Range Bias: -0.38m
Solve RMS: 16.69ps
Final RMS: 16.69ps
Fit Residual (ps)
Epoch on date 23/06/2020

Stella

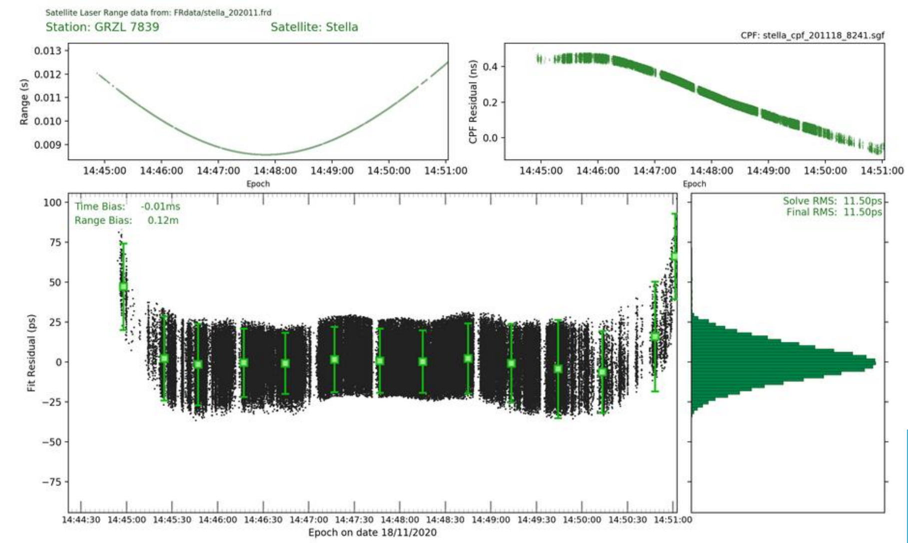
- Graz



Satellite Laser Range data from: FRdata/stella_202011.frd
Station: GRZL 7839
Satellite: Stella
CPF: stella_cpf_201118_8232.dgf
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.00ms
Range Bias: 0.16m
Solve RMS: 11.83ps
Final RMS: 11.83ps
Fit Residual (ps)
Epoch on date 18/11/2020



Satellite Laser Range data from: FRdata/stella_202011.frd
Station: GRZL 7839
Satellite: Stella
CPF: stella_cpf_201118_8231.hts
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -1.11ms
Range Bias: -0.39m
Solve RMS: 11.47ps
Final RMS: 11.47ps
Fit Residual (ps)
Epoch on date 18/11/2020



Satellite Laser Range data from: FRdata/stella_202011.frd
Station: GRZL 7839
Satellite: Stella
CPF: stella_cpf_201118_8241.sgf
Range (s)
CPF Residual (ns)
Epoch
Time Bias: -0.01ms
Range Bias: 0.12m
Solve RMS: 11.50ps
Final RMS: 11.50ps
Fit Residual (ps)
Epoch on date 18/11/2020

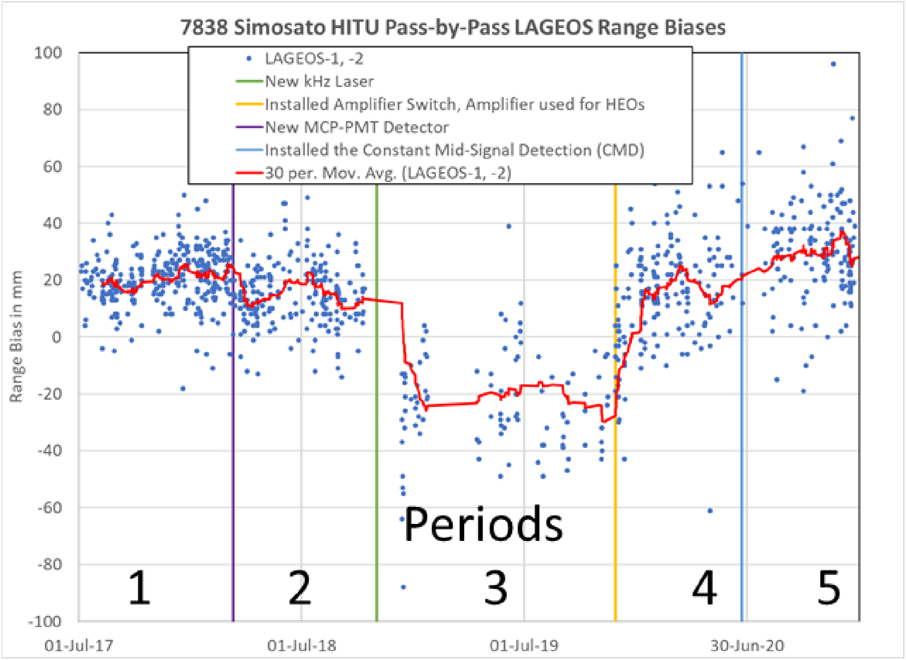
7838 Simosato Update
January 2021

Van S Husson
vhusson@peraton.com
ILRS Quality Control Board

7838 Simosato Site and History Log Status

- Site Log was updated in December 2020 and approved January 2021
  - Removed the ‘04’ occupation in Section 3
  - Updated Calibration Section 8 for clarity
    - March 1, 1982 to June 30, 2006: Calibration target at 1414.699 meters (m)
    - July 1 to August 3, 2006: experimented with 16.490 m target
    - August 4-31, 2006: remeasured long target, new range was 1414.710 m (11 mm change)
    - September 1-14 2006: experimented again with 16.490 m target
    - September 15, 2006 to June 3, 2015: long target at 1414.710 m
    - June 4, 2015 to present: target at 0 m (on the telescope frame)
- Station History
  - No change since last meeting, they asked advice on the data impact flag
  - They still need to merge their old history log with their new history log

JCET and HITU LAGEOS 7838 Range Bias Analysis

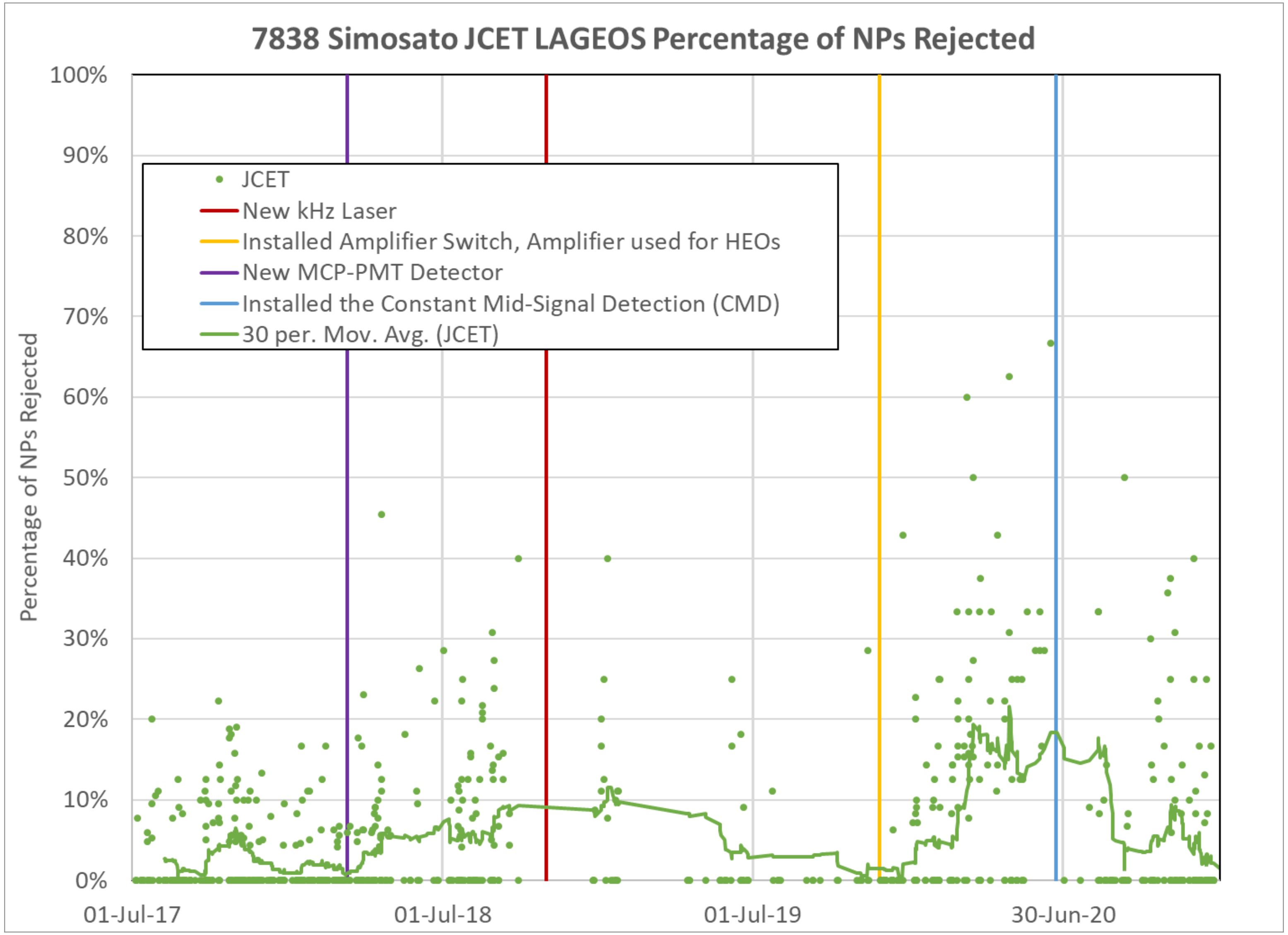


JCET weekly L2 biases on the left
And HITU L1 and L2 pass-by-pass biases on the right. Good agreement after editing gross outliers:

Gross LAGEOS Outliers since July 2017:
June 1 to 4, 2018: 180 µsec time bias
(see Rapidmail # 137)

Following L2 passes had meter biases:
April 7, 2020 at 2:48
April 8, 2020 at 0:45 and 4:49
August 5, 2020 at 6:01

7838 JCET NP Rejection Percentage by Pass



In the daily bias reports from the Analysis Centers, range and time biases are computed per pass along with the number of normal points (NPs) accepted and rejected. HITU usually accepts all normal points including Simosato, but the other centers have higher NP rejection rates.

On the left is the JCET pass-by-pass LAGEO NP rejection rates for each Simosato pass.

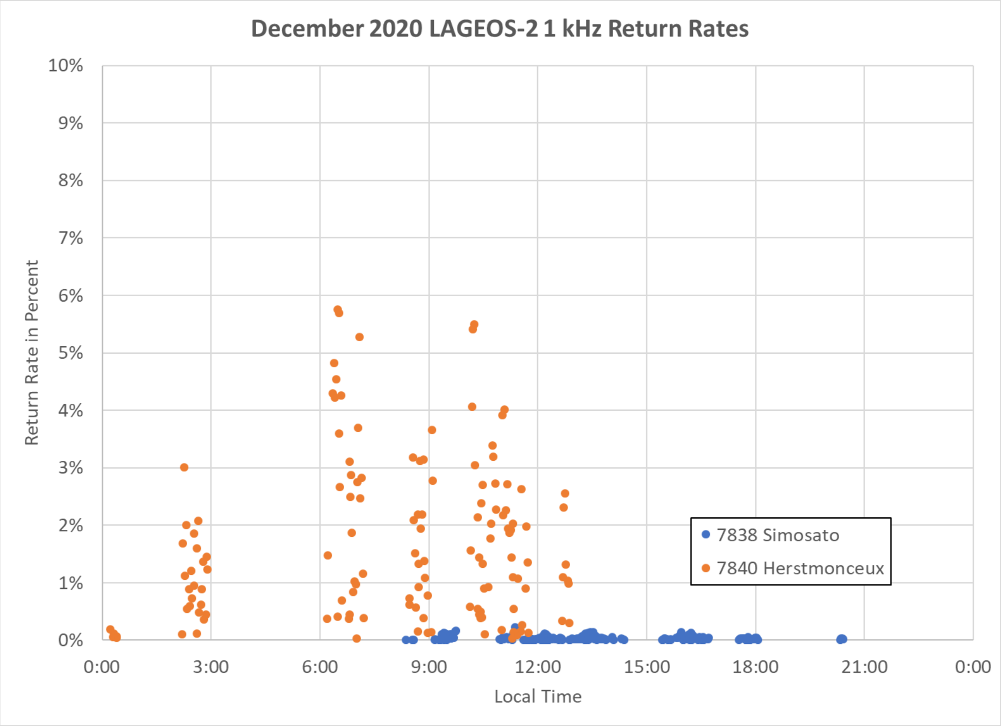
Are these inconsistent NPs within a pass kept in the weekly solution estimates?

If they are kept are they corrupting the solution?

Dec 2020 1kHz LAGEOS-2 Return Rate Analysis

Herstmonceux Laser

Laser Type : ND:YAG
Secondary Wavelength [nm]: 532
Secondary Max. Energy [mJ]: 1.0
Pulse Width (FWHM) [ps]: 10
Max. Repetition Rate [Hz]: 1000
Fullw. Beam Divergence ["]: 5 - 200
Final Beam Diameter [m]: 0.03



Simosato Laser

Laser Type : ND:YAG
Secondary Wavelength [nm]: 532
Secondary Max. Energy [mJ]: 3
Pulse Width (FWHM) [ps]: 30
Max. Repetition Rate [Hz]: 1,000
Fullw. Beam Divergence ["]: 6 - 20
Final Beam Diameter [m]: 0.75

Simosato operated mostly in the day time in December. Simosato maximum LAGEOS -2 receive rate in December 2020 was 0.2 %, and their average return rate was 0.03 %. While Herstmonceux average return rate was 1.7 %.