RINEX Observation Analysis

3PfD

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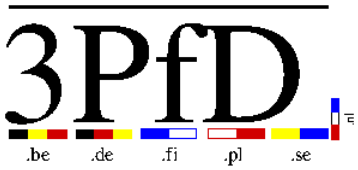
RMA – CISS, M3Systems SPRL



May 4, 2021

Contents

List of Tables

List of Figures

1 Experiment basic information

- **Operators**
  - Pascal De Kimpe
  - Avag Tsaturyan
- **Location / Date**
  - RMA LAB H local 50/14
  - 14 December 2020
- **Short description of Experiment**
  - Set-up
    * RFI jamming on GAL E1 PRS code with 64QAM & CST signals wide bandwidth
    * preservation of Galileo E6 PRS
    * Jammer is VST generator from M3systems and Recorder with Stella Software
    * Laboratory setup using Directionnal coupleur and Splitter Amplifier
  - Receivers used
    * AsteRx SB
    * TURP
    * P3RS2
- **Log files**

AsteRX_SB TURP	H50_14DEC14JammingQAM64_0000.sbf BEGP349(K|L|O).20_.sbf
P3RS2	P3RS-2_RX_R_20203491039_15M_00U_MO.rnx
	P3RS-2_RX_R_20203491054_15M_00U_MO.rnx
	P3RS-2_RX_R_20203491409_15M_00U_MO.rnx
	P3RS-2_RX_R_20203491424_15M_00U_MO.rnx

2 Experiment set-up

Set-up of OS RFI jamming

Parameter	Value
- targeted navigation signal	- PRS E1A
	- GPS C/A @ L1
	- Galileo OS E1BC
- targeted frequency	L1/E1 @ 1575.42 MHz
- targeted bandwidth	40 MHz
- power of targeted signal(s)	$\pm$ (-127) dBm
Preserved navigation service	
- preserved navigation service	- Galileo PRS (single or dual band)
- preserved navigation signals	- PRS E6A
Receivers	TUR-P, P3RS2, AsteRx_SB
- start status	Warm using live signals (PNT & Ephemeris ok)
- logging frequency	1 Hz
- troposphere model	Saastamoinen
- ionosphere model	Klobuchar
Jamming scenario	
- jamming signal	CST @ L1 sweep time $\pm 100 \mu s$, BW 40 MHz, increase power
- interference power	[-100 : 3 : -77 : 2 : - 59 : 1 : -40] dBm
- interference timing	[20 : 10 : 10]
- RFI Start Time	14:10:01
- RFI Scenario file	CST-jamming.csv
Location	
- RMA Antenna	50.8440152778N / 4.3929283333E / 151.39179

Parameter	Value
Metrics	
- Carrier-to-Noise	L1-C/A, Gal OS, Gal PRS E1 / E6
- number of satellites	in PNT fix
- loss of (first) satellites	time & duration
- loss of PNT	time & duration
- reacquisition of (first) satellites	time & duration
- reacquisition of PNT	time & duration
- AGC (automatic gain control)	if available
- PNT accuracy	log vs time
- recovery time or SINR level	time needed during or after scenario

3 Analysis of RINEX Observation file

3.1 Script details

3.1.1 Program information

Script	:	rnxobs_tabular.py
Run at	:	04/05/2021 15:52
Run by	:	A. Muls
		Royal Military Academy

3.1.2 Parameters

RINEX root directory	:	/home/amuls/RxTURP/RFI/CST/rnx/20349
RINEX observation file	:	SEPT00BEL_R_20203491400_30M_01S_MO.rnx
RINEX version	:	3.04
Marker	:	SEPT00BEL
Year/day-of-year	:	2020/349

3.1.3 Observation header information

First epoch	:	2020/12/14 14:00:00
Last epoch	:	2020/12/14 14:30:00
Interval	:	1.0
GNSS	:	E (Galileo)
	:	G (GPS NavSTAR)
Frequencies E	:	1
Frequencies G	:	1
Observable types	:	S (Pseudorange)
	:	C (SNR)
	:	D (Doppler)

: L (Carrier)

3.1.4 Logged observables

Observable types E : C1C, D1C, L1C, S1C

Observable types G : C1C, D1C, L1C, S1C

3.2 Analysis of observation statistics for Galileo

statistics observation file : SEPT00BEL_R_20203491400_30M_01S_MO_E.obsstat

navigation signals : E1C

3.2.1 Observables count per navigation signal

The following table represents the number of observations made for each examined navigation signal. The percentages per navigation signal are calculated by dividing by the number of observations obtained from Two Line Elements (TLE) at the recorded interval. The last column represents the number of observations possible during the observed time interval.

PRN	E1C		TLE_count
E02	1503	83.5%	1800.0
E03	1524	84.7%	1800.0
E05	1491	82.8%	1800.0
E07	29	1.6%	1800.0
E08	1524	84.7%	1800.0
E24	1492	82.9%	1800.0
E25	1521	84.5%	1800.0
E26	625	34.7%	1800.0
E33	118	6.6%	1800.0

Figure 1 represents the absolute count of observables for each navigation signal set out against the maximum possible observations obtained from the TLEs. The relative observation count is represented in Figure 2.

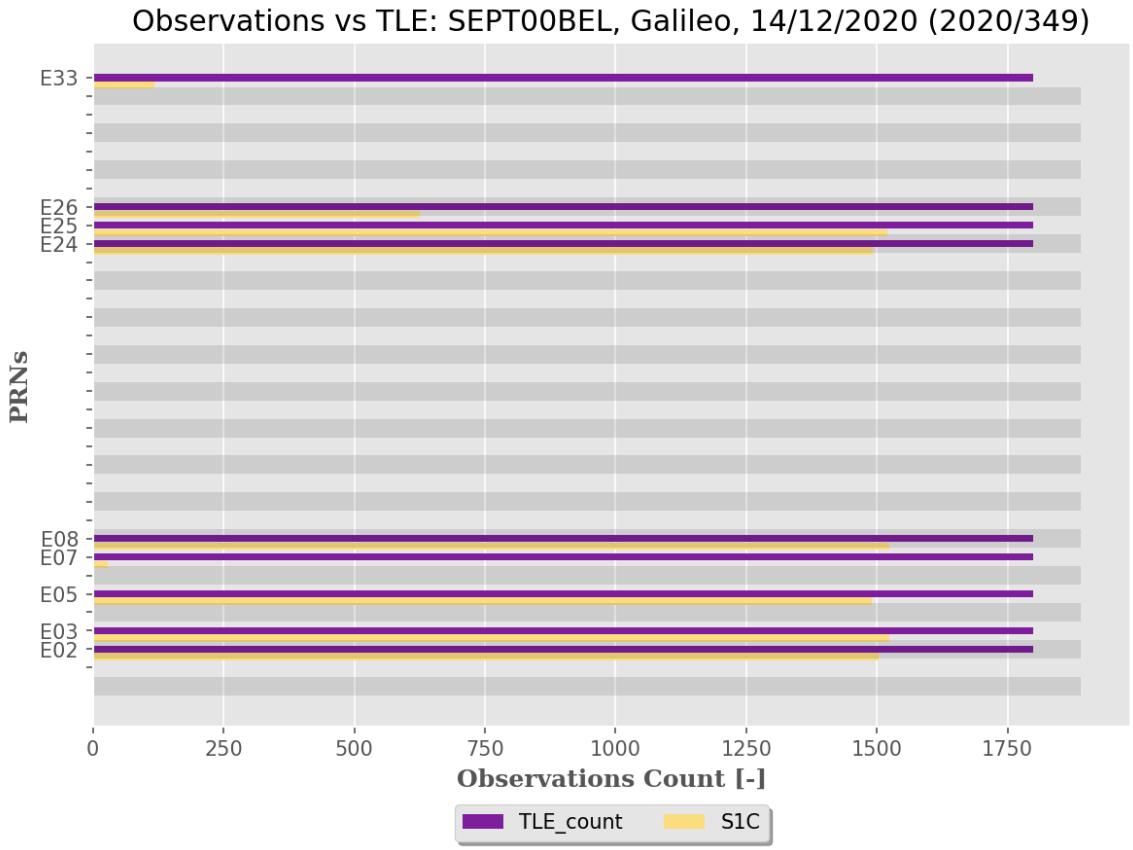


Figure 1: Observables overview for GNSS Galileo

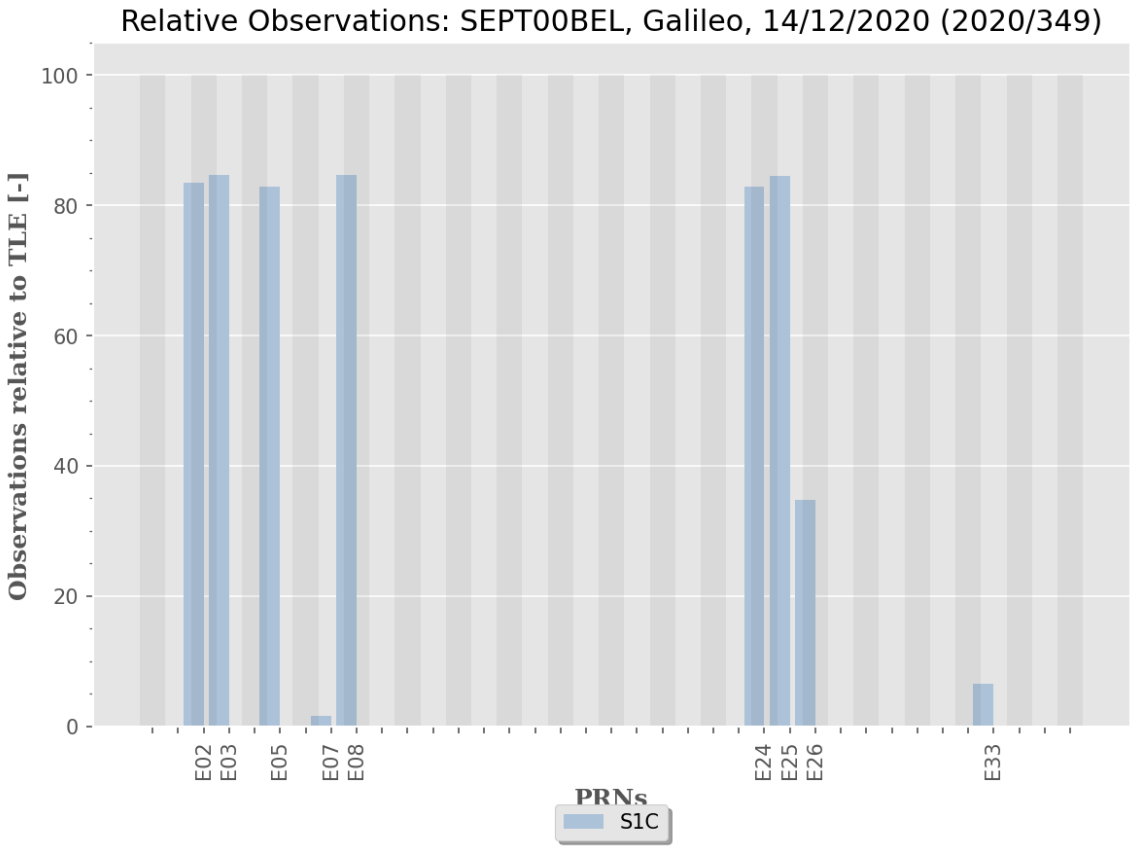


Figure 2: Relative observation count per navigation signal for GNSS Galileo

3.3 Analysis of observation statistics for GPS NavSTAR

statistics observation file : SEPT00BEL_R_20203491400_30M_01S_MO_G.obsstat

navigation signals : G1C

3.3.1 Observables count per navigation signal

The following table represents the number of observations made for each examined navigation signal. The percentages per navigation signal are calculated by dividing by the number of observations obtained from Two Line Elements (TLE) at the recorded interval. The last column represents the number of observations possible during the observed time interval.

PRN	G1C		TLE_count
G05	1490	82.8%	1800.0
G08	313	17.4%	1800.0
G10	439	24.4%	1800.0
G11	357	19.8%	1800.0
G13	1529	84.9%	1800.0
G14	1543	85.7%	1800.0
G15	1528	84.9%	1800.0
G17	1478	82.1%	1800.0
G18	799	---	0
G19	18	1.0%	1800.0
G20	1501	83.4%	1800.0
G23	1491	82.8%	1800.0
G24	1511	83.9%	1800.0
G28	1548	86.0%	1800.0
G30	1491	82.8%	1800.0

Figure 3 represents the absolute count of observables for each navigation signal set out against the maximum possible observations obtained from the TLEs. The relative observation count is represented in Figure 4.

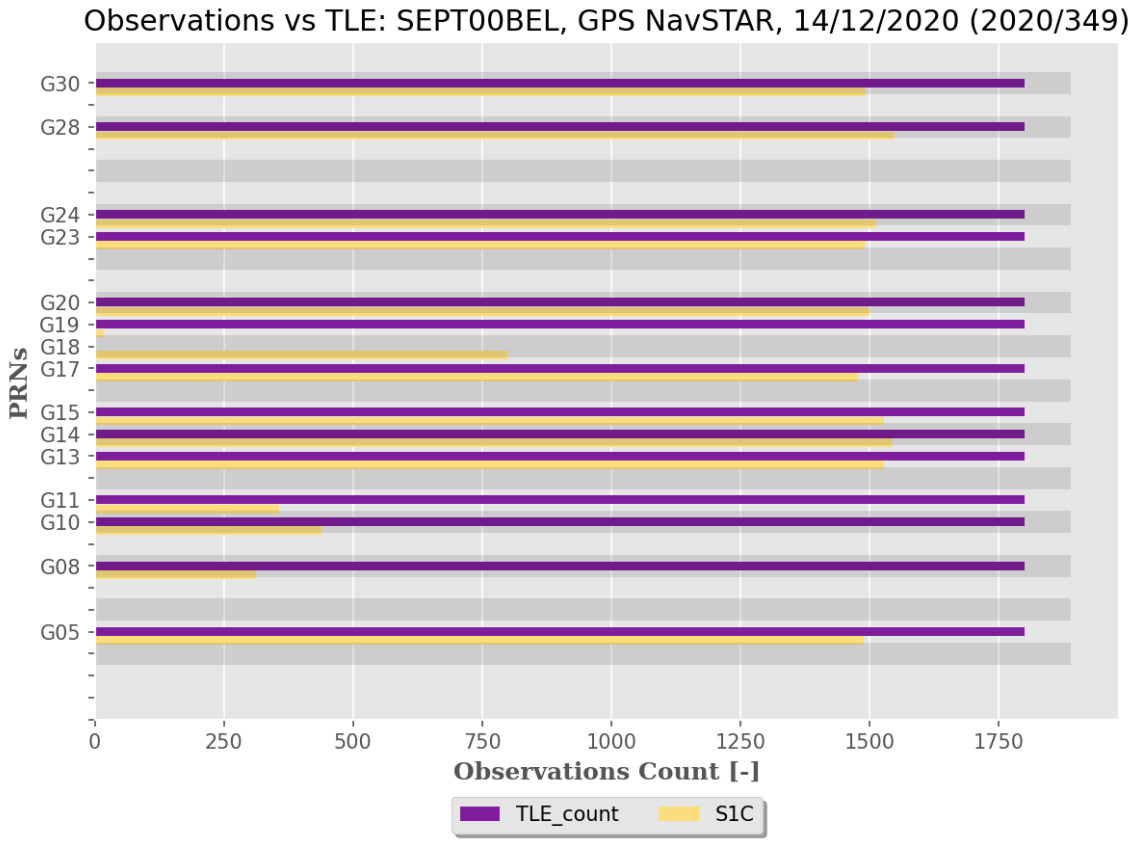


Figure 3: Observables overview for GNSS GPS NavSTAR

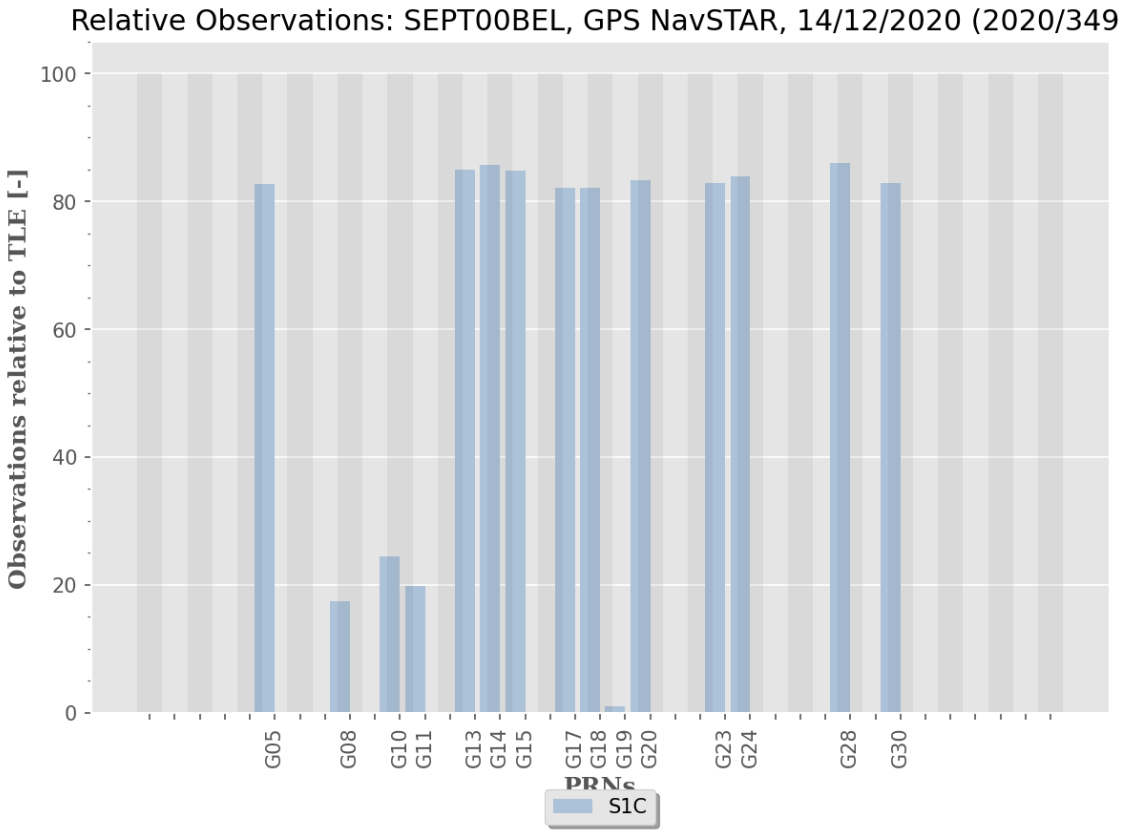


Figure 4: Relative observation count per navigation signal for GNSS GPS NavSTAR

3.4 Detailed analysis of observation types per navigation signal for Galileo

Observation tabular file : SEPT00BEL_R_20203491400_30M_01S_MO_E.obstab
Examined satellites : E02, E03, E05, E07, E08, E24, E25, E26, E33
Examined navigation signals : 1C
Examined observables : S1C

3.4.1 TLE time spans

The table below represents the calculated rise and set times within the observation time span for a PRN based on the TLEs. When a culmination is within this interval, it is represented in the table.

PRN	tle_rise	tle_set	tle_cul	tle_arc_count
E02	14:00:00	14:30:00		1800.0
E03	14:00:00	14:30:00		1800.0
E05	14:00:00	14:30:00		1800.0
E08	14:00:00	14:30:00		1800.0
E24	14:00:00	14:30:00		1800.0
E25	14:00:00	14:30:00	14:17:37	1800.0
E26	14:00:00	14:30:00		1800.0
E07	14:00:00	14:30:00		1800.0
E33	14:00:00	14:30:00		1800.0

3.4.2 Navigation signals analysis for Galileo

Analysis of navigation signal E1C

1. Figure 5 represents the observed time span for navigation signal E1C set out against the maximum time span calculated from the Two Line Elements (TLE). If present, the culmination point for a satellite is represented by a triangle. The time span from TLEs is represented by the lighter area while the real observations are represented by the dark super-imposed areas.

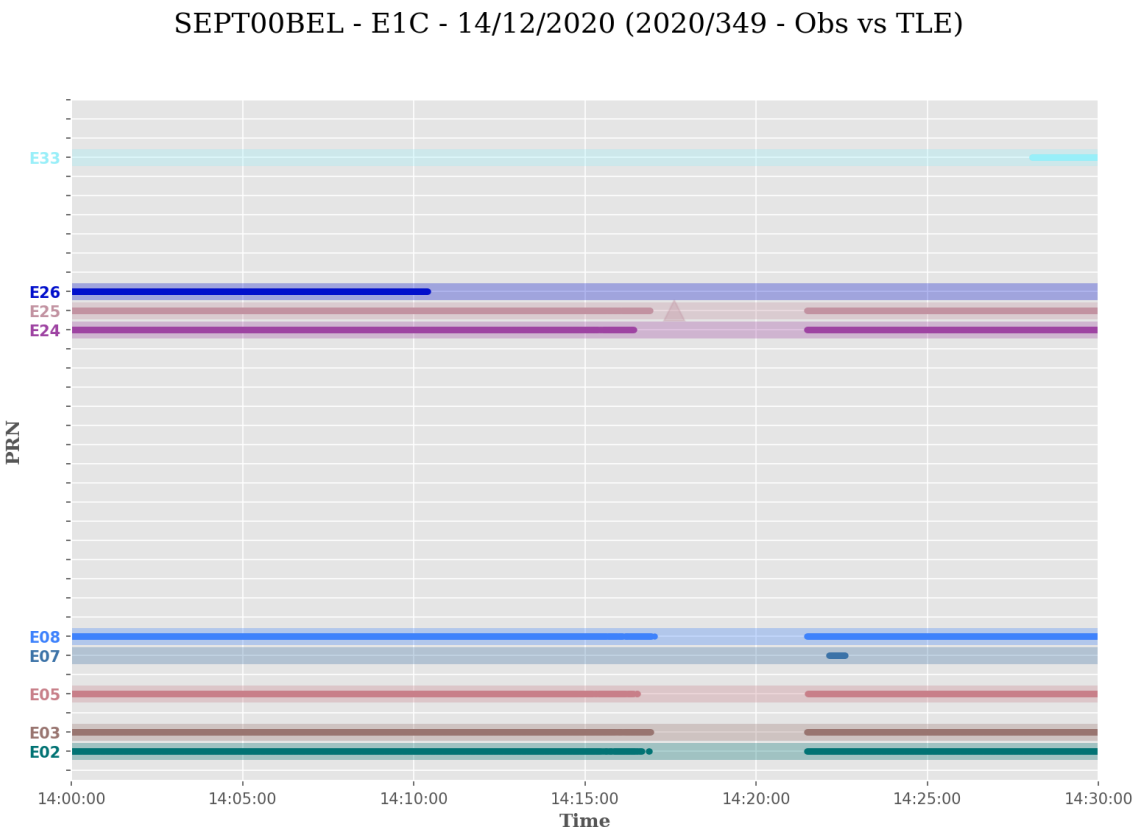


Figure 5: Navigation signal E1C versus TLE time span

2. Figure 6 displays the evolution of observation type S1C.
   The upper plot represents the variation of the observation type while the middle plot (if available) displays the variation of this observable between 2 consecutive epochs. The bottom plot displays the TLE time spans for the satellies.

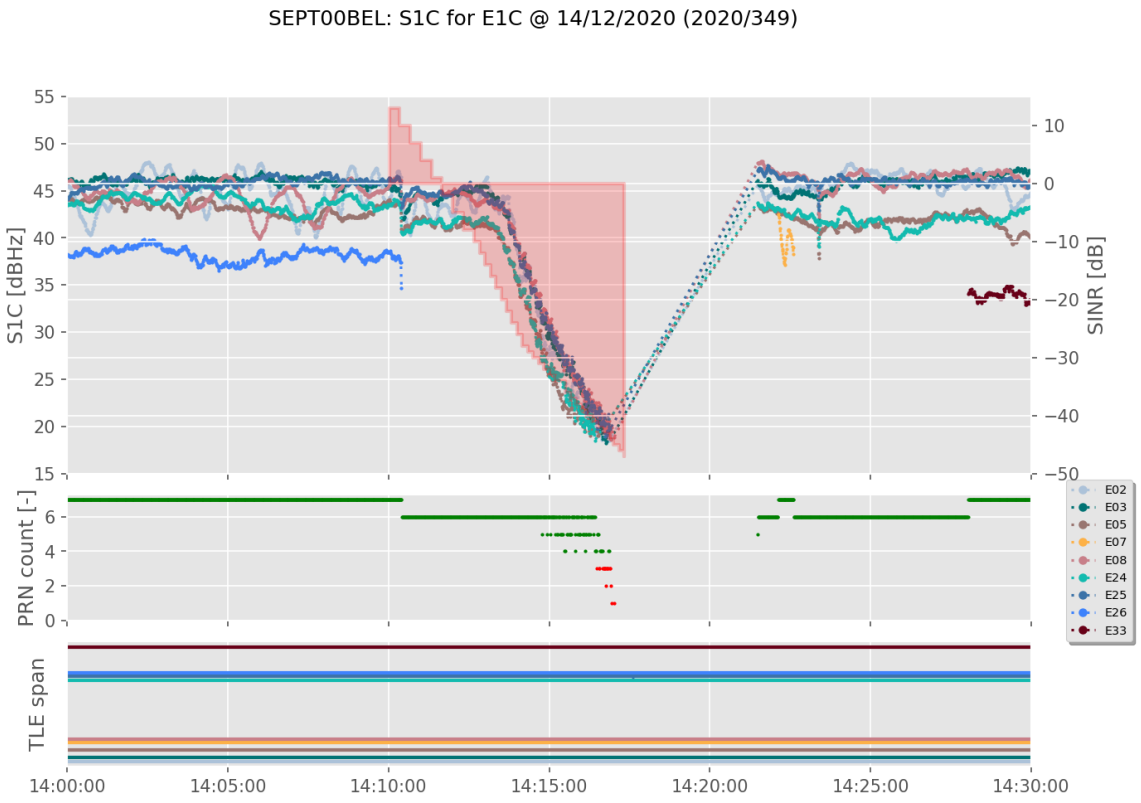


Figure 6: Navigation signal S1C evolution

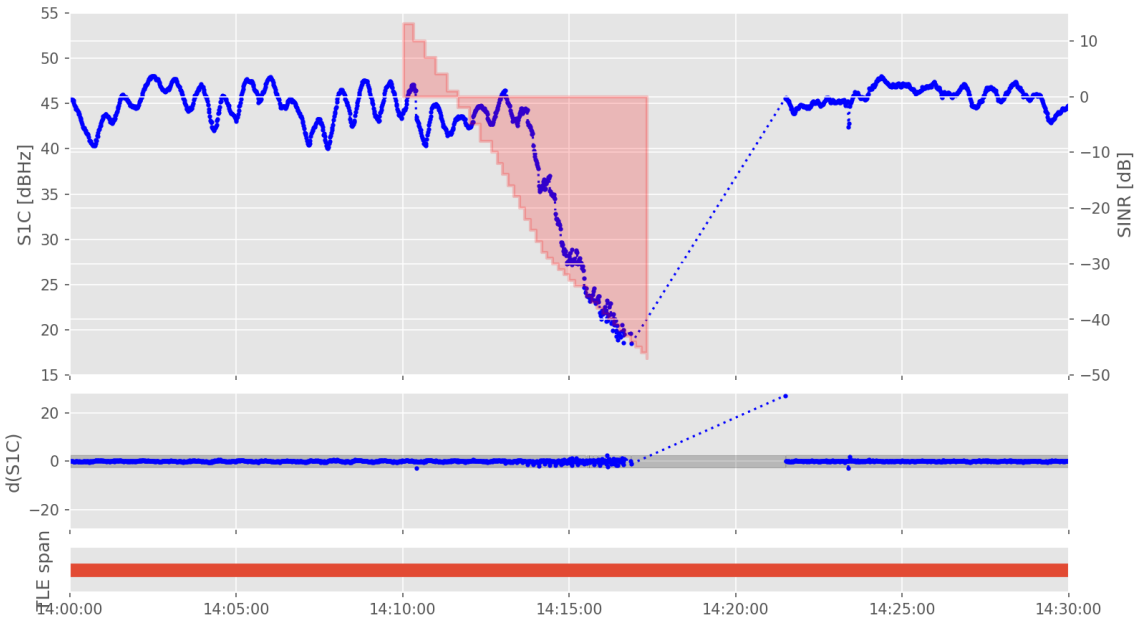
The table below reports the loss and reacquisition of PNT for observable S1C.

Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:16:28	Loss	PNT	2.0	2020-12-14 14:16:30
2020-12-14 14:16:32	Loss	PNT	3.0	2020-12-14 14:16:35
2020-12-14 14:16:39	Loss	PNT	12.0	2020-12-14 14:16:51
2020-12-14 14:16:52	Loss	PNT	277.0	2020-12-14 14:21:29

3. Analysis of navigation signal E1C for each observed satellite.
   ewline The following plots display the same information as described above per satellite. Each plot is accompanied by a table displaying the time of loss of lock and reacquisition of the satellite when such events are detected.

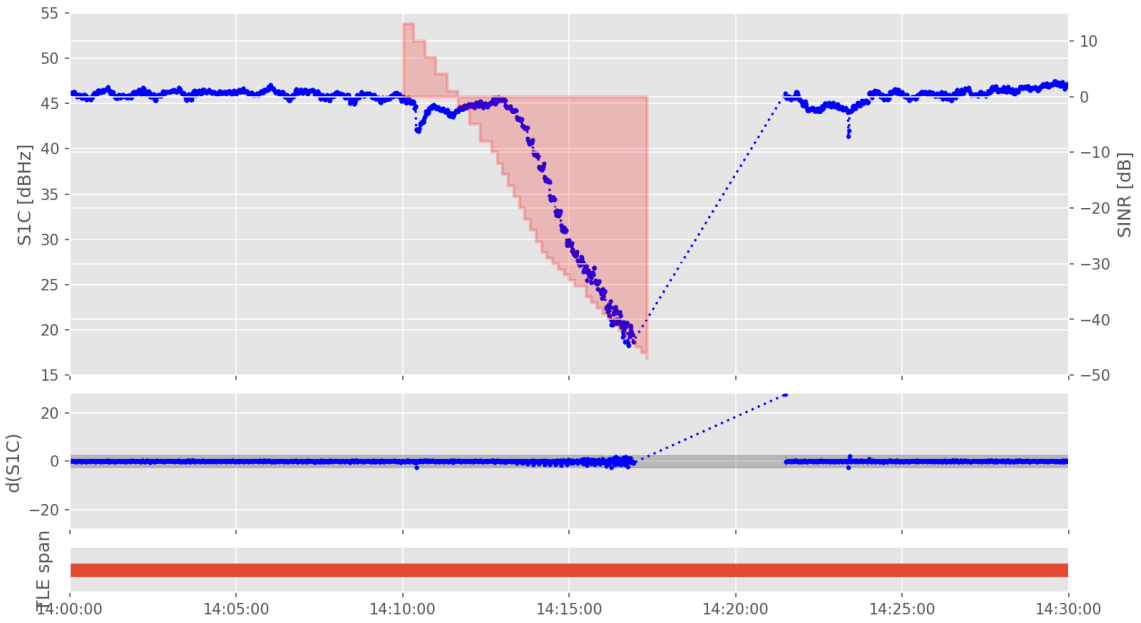
SEPT00BEL: S1C for E02 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:27	Loss	E02	2.0	2020-12-14 14:15:29
2020-12-14 14:15:29	Loss	E02	2.0	2020-12-14 14:15:31
2020-12-14 14:15:32	Loss	E02	3.0	2020-12-14 14:15:35
2020-12-14 14:15:39	Loss	E02	3.0	2020-12-14 14:15:42
2020-12-14 14:15:47	Loss	E02	3.0	2020-12-14 14:15:50
2020-12-14 14:16:28	Loss	E02	2.0	2020-12-14 14:16:30
2020-12-14 14:16:32	Loss	E02	3.0	2020-12-14 14:16:35
2020-12-14 14:16:39	Loss	E02	12.0	2020-12-14 14:16:51
2020-12-14 14:16:52	Loss	E02	277.0	2020-12-14 14:21:29

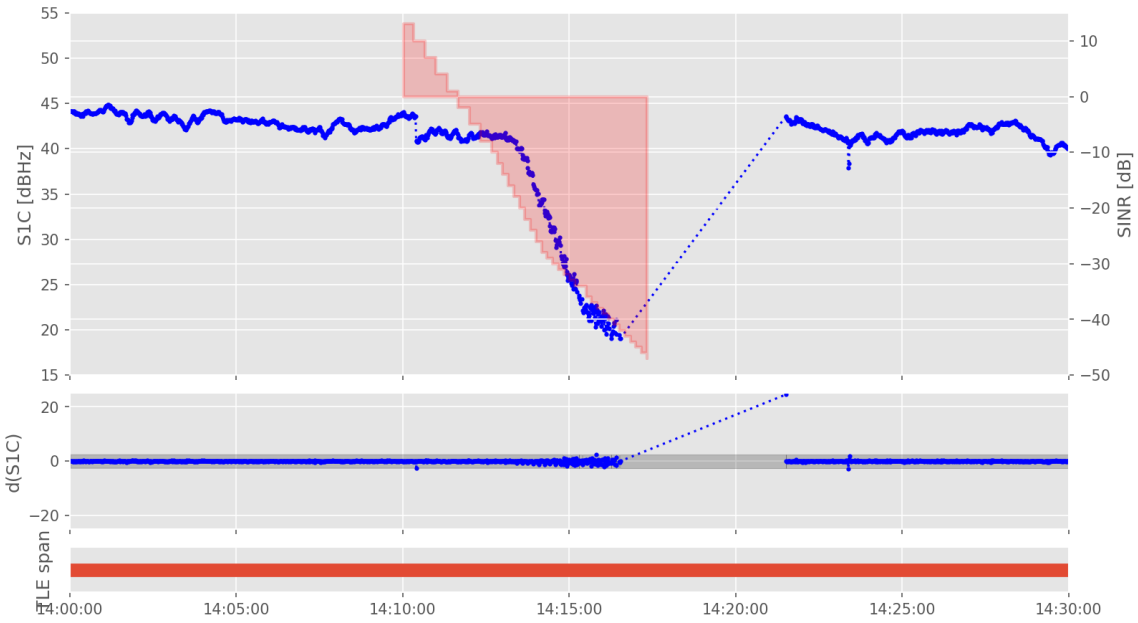
SEPT00BEL: S1C for E03 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:52	Loss	E03	2.0	2020-12-14 14:15:54
2020-12-14 14:15:55	Loss	E03	2.0	2020-12-14 14:15:57
2020-12-14 14:16:04	Loss	E03	2.0	2020-12-14 14:16:06
2020-12-14 14:16:06	Loss	E03	2.0	2020-12-14 14:16:08
2020-12-14 14:16:55	Loss	E03	274.0	2020-12-14 14:21:29

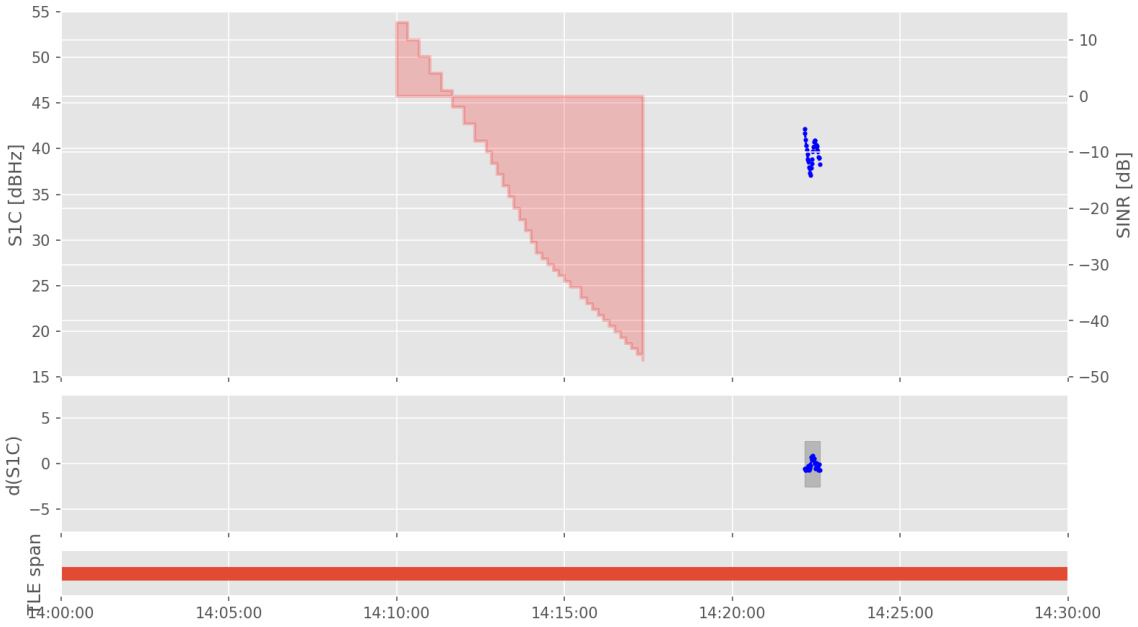
SEPT00BEL: S1C for E05 @ 14/12/2020 (2020/349)



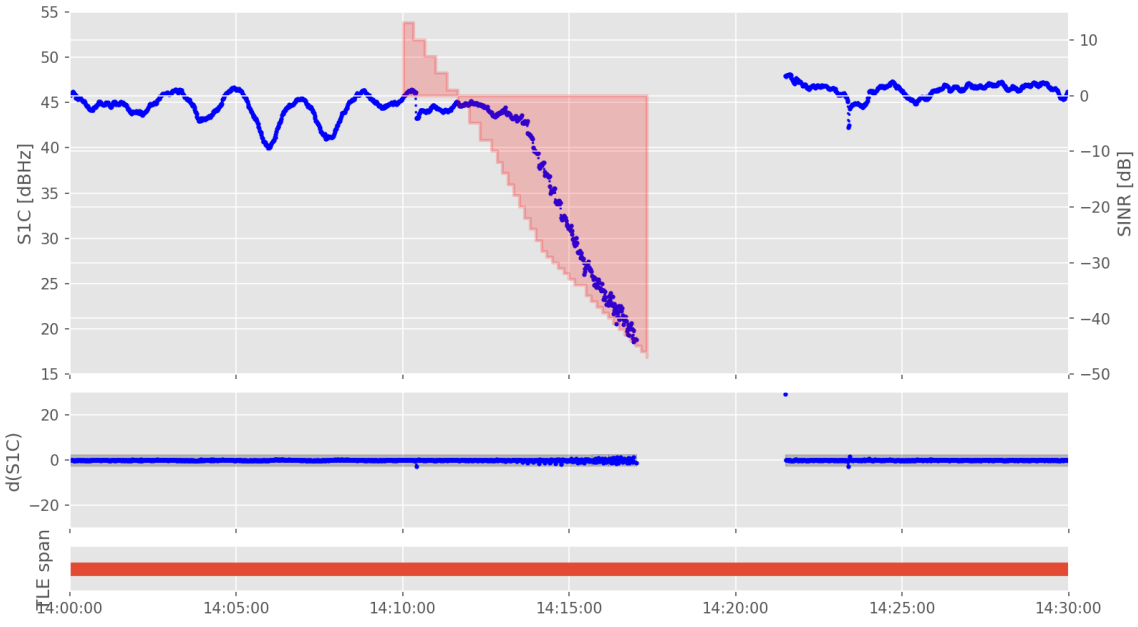
Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:14:46	Loss	E05	2.0	2020-12-14 14:14:48
2020-12-14 14:15:01	Loss	E05	2.0	2020-12-14 14:15:03
2020-12-14 14:15:14	Loss	E05	3.0	2020-12-14 14:15:17
2020-12-14 14:15:20	Loss	E05	3.0	2020-12-14 14:15:23
2020-12-14 14:16:12	Loss	E05	3.0	2020-12-14 14:16:15
2020-12-14 14:16:22	Loss	E05	2.0	2020-12-14 14:16:24
2020-12-14 14:16:25	Loss	E05	5.0	2020-12-14 14:16:30
2020-12-14 14:16:32	Loss	E05	298.0	2020-12-14 14:21:30

SEPT00BEL: S1C for E07 @ 14/12/2020 (2020/349)



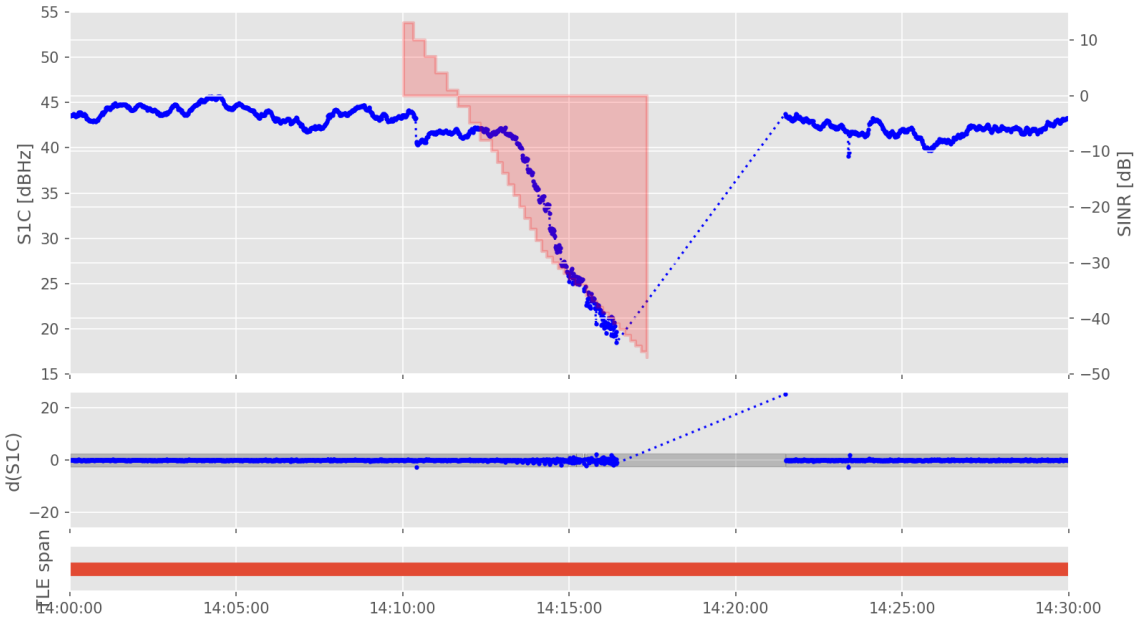
SEPT00BEL: S1C for E08 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:38	Loss	E08	2.0	2020-12-14 14:15:40
2020-12-14 14:15:57	Loss	E08	2.0	2020-12-14 14:15:59
2020-12-14 14:16:06	Loss	E08	4.0	2020-12-14 14:16:10
2020-12-14 14:16:15	Loss	E08	2.0	2020-12-14 14:16:17
2020-12-14 14:16:56	Loss	E08	5.0	2020-12-14 14:17:01
2020-12-14 14:17:01	Loss	E08	268.0	2020-12-14 14:21:29

SEPT00BEL: S1C for E24 @ 14/12/2020 (2020/349)



Navigation signal 1C

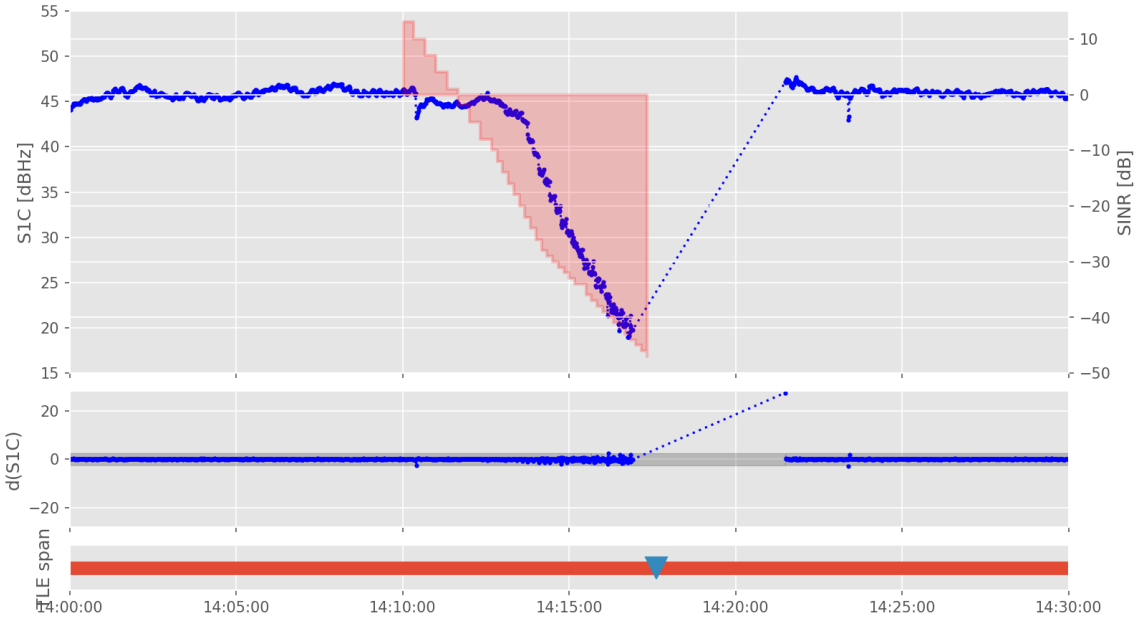
DATE_TIME	event	type	duration	reacq
2020-12-14 14:14:55	Loss	E24	2.0	2020-12-14 14:14:57
2020-12-14 14:15:10	Loss	E24	2.0	2020-12-14 14:15:12
2020-12-14 14:15:22	Loss	E24	2.0	2020-12-14 14:15:24
2020-12-14 14:15:24	Loss	E24	2.0	2020-12-14 14:15:26
2020-12-14 14:15:27	Loss	E24	2.0	2020-12-14 14:15:29

Continued on Next Page

Navigation signal 1C

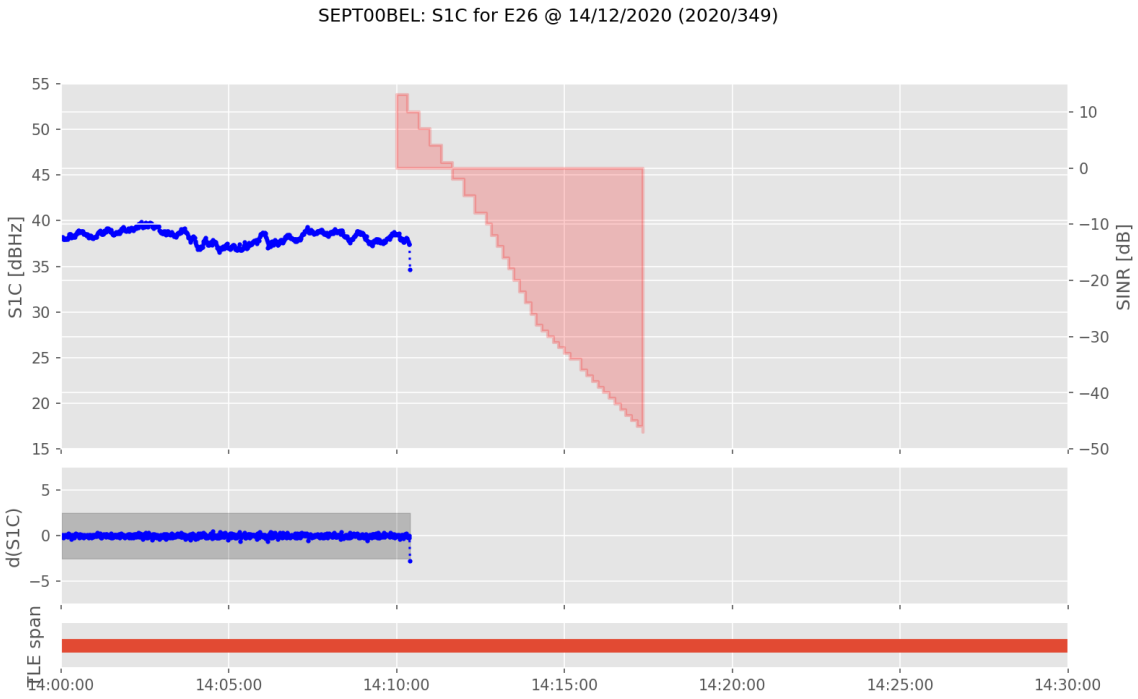
DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:29	Loss	E24	2.0	2020-12-14 14:15:31
2020-12-14 14:16:25	Loss	E24	304.0	2020-12-14 14:21:29

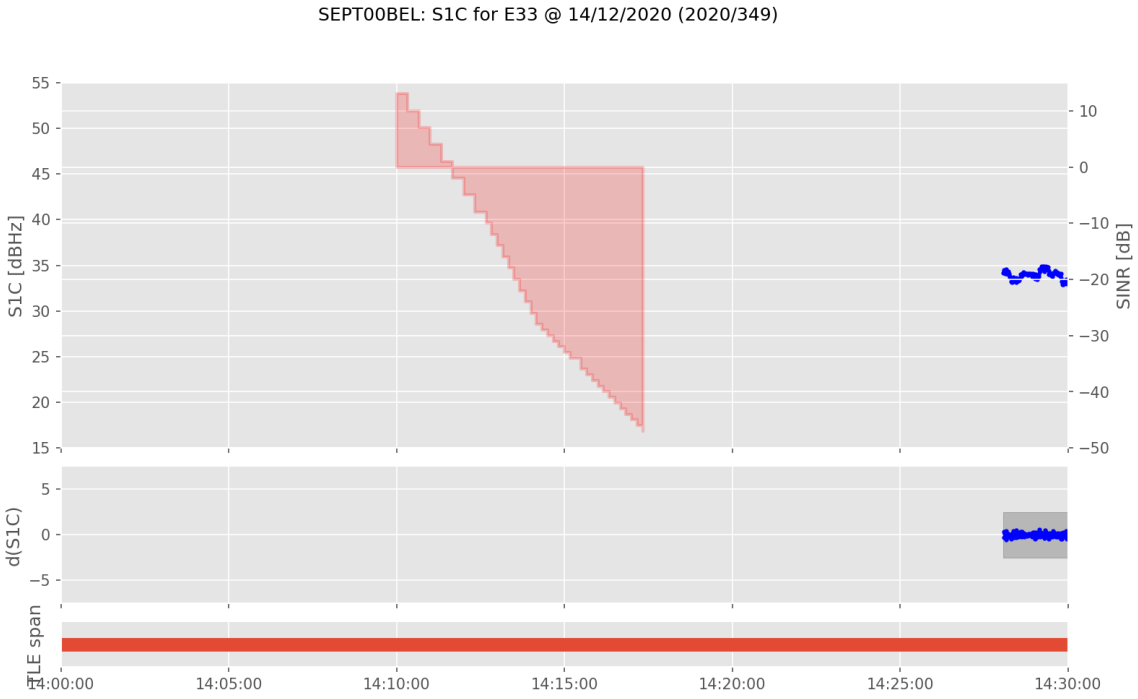
SEPT00BEL: S1C for E25 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:37	Loss	E25	2.0	2020-12-14 14:15:39
2020-12-14 14:15:47	Loss	E25	2.0	2020-12-14 14:15:49
2020-12-14 14:15:56	Loss	E25	2.0	2020-12-14 14:15:58
2020-12-14 14:16:01	Loss	E25	2.0	2020-12-14 14:16:03
2020-12-14 14:16:03	Loss	E25	2.0	2020-12-14 14:16:05
2020-12-14 14:16:45	Loss	E25	2.0	2020-12-14 14:16:47
2020-12-14 14:16:54	Loss	E25	275.0	2020-12-14 14:21:29





4. Chronological overview of detected events for navigation signal E1C

Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:14:46	Loss	E05	2.0
2020-12-14 14:14:48	Reacquisition	E05	nan
2020-12-14 14:14:55	Loss	E24	2.0
2020-12-14 14:14:57	Reacquisition	E24	nan
2020-12-14 14:15:01	Loss	E05	2.0
2020-12-14 14:15:03	Reacquisition	E05	nan
2020-12-14 14:15:10	Loss	E24	2.0
2020-12-14 14:15:12	Reacquisition	E24	nan
2020-12-14 14:15:14	Loss	E05	3.0
2020-12-14 14:15:17	Reacquisition	E05	nan
2020-12-14 14:15:20	Loss	E05	3.0
2020-12-14 14:15:22	Loss	E24	2.0
2020-12-14 14:15:23	Reacquisition	E05	nan
2020-12-14 14:15:24	Reacquisition	E24	nan
2020-12-14 14:15:24	Loss	E24	2.0
2020-12-14 14:15:26	Reacquisition	E24	nan
2020-12-14 14:15:27	Loss	E02	2.0
2020-12-14 14:15:27	Loss	E24	2.0
2020-12-14 14:15:29	Loss	E02	2.0
2020-12-14 14:15:29	Reacquisition	E02	nan
2020-12-14 14:15:29	Loss	E24	2.0
2020-12-14 14:15:29	Reacquisition	E24	nan
2020-12-14 14:15:31	Reacquisition	E24	nan
2020-12-14 14:15:31	Reacquisition	E02	nan
2020-12-14 14:15:32	Loss	E02	3.0
2020-12-14 14:15:35	Reacquisition	E02	nan
2020-12-14 14:15:37	Loss	E25	2.0
2020-12-14 14:15:38	Loss	E08	2.0
2020-12-14 14:15:39	Loss	E02	3.0

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Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:15:39	Reacquisition	E25	nan
2020-12-14 14:15:40	Reacquisition	E08	nan
2020-12-14 14:15:42	Reacquisition	E02	nan
2020-12-14 14:15:47	Loss	E25	2.0
2020-12-14 14:15:47	Loss	E02	3.0
2020-12-14 14:15:49	Reacquisition	E25	nan
2020-12-14 14:15:50	Reacquisition	E02	nan
2020-12-14 14:15:52	Loss	E03	2.0
2020-12-14 14:15:54	Reacquisition	E03	nan
2020-12-14 14:15:55	Loss	E03	2.0
2020-12-14 14:15:56	Loss	E25	2.0
2020-12-14 14:15:57	Loss	E08	2.0
2020-12-14 14:15:57	Reacquisition	E03	nan
2020-12-14 14:15:58	Reacquisition	E25	nan
2020-12-14 14:15:59	Reacquisition	E08	nan
2020-12-14 14:16:01	Loss	E25	2.0
2020-12-14 14:16:03	Reacquisition	E25	nan
2020-12-14 14:16:03	Loss	E25	2.0
2020-12-14 14:16:04	Loss	E03	2.0
2020-12-14 14:16:05	Reacquisition	E25	nan
2020-12-14 14:16:06	Loss	E08	4.0
2020-12-14 14:16:06	Reacquisition	E03	nan
2020-12-14 14:16:06	Loss	E03	2.0
2020-12-14 14:16:08	Reacquisition	E03	nan
2020-12-14 14:16:10	Reacquisition	E08	nan
2020-12-14 14:16:12	Loss	E05	3.0
2020-12-14 14:16:15	Reacquisition	E05	nan
2020-12-14 14:16:15	Loss	E08	2.0
2020-12-14 14:16:17	Reacquisition	E08	nan
2020-12-14 14:16:22	Loss	E05	2.0

Continued on Next Page

Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:16:24	Reacquisition	E05	nan
2020-12-14 14:16:25	Loss	E05	5.0
2020-12-14 14:16:25	Loss	E24	304.0
2020-12-14 14:16:28	Loss	PNT	2.0
2020-12-14 14:16:28	Loss	E02	2.0
2020-12-14 14:16:30	Reacquisition	PNT	nan
2020-12-14 14:16:30	Reacquisition	E05	nan
2020-12-14 14:16:30	Reacquisition	E02	nan
2020-12-14 14:16:32	Loss	PNT	3.0
2020-12-14 14:16:32	Loss	E02	3.0
2020-12-14 14:16:32	Loss	E05	298.0
2020-12-14 14:16:35	Reacquisition	E02	nan
2020-12-14 14:16:35	Reacquisition	PNT	nan
2020-12-14 14:16:39	Loss	PNT	12.0
2020-12-14 14:16:39	Loss	E02	12.0
2020-12-14 14:16:45	Loss	E25	2.0
2020-12-14 14:16:47	Reacquisition	E25	nan
2020-12-14 14:16:51	Reacquisition	E02	nan
2020-12-14 14:16:51	Reacquisition	PNT	nan
2020-12-14 14:16:52	Loss	PNT	277.0
2020-12-14 14:16:52	Loss	E02	277.0
2020-12-14 14:16:54	Loss	E25	275.0
2020-12-14 14:16:55	Loss	E03	274.0
2020-12-14 14:16:56	Loss	E08	5.0
2020-12-14 14:17:01	Reacquisition	E08	nan
2020-12-14 14:17:01	Loss	E08	268.0
2020-12-14 14:21:29	Reacquisition	E08	nan
2020-12-14 14:21:29	Reacquisition	E24	nan
2020-12-14 14:21:29	Reacquisition	E02	nan
2020-12-14 14:21:29	Reacquisition	E03	nan

Continued on Next Page

Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:21:29	Reacquisition	PNT	nan
2020-12-14 14:21:29	Reacquisition	E25	nan
2020-12-14 14:21:30	Reacquisition	E05	nan

3.5 Detailed analysis of observation types per navigation signal for GPS NavSTAR

Observation tabular file : SEPT00BEL_R_20203491400_30M_01S_MO_G.obstab
Examined satellites : G05, G08, G10, G11, G13, G14, G15, G17, G18, G19
G20, G23, G24, G28, G30
Examined navigation signals : 1C
Examined observables : S1C

3.5.1 TLE time spans

The table below represents the calculated rise and set times within the observation time span for a PRN based on the TLEs. When a culmination is within this interval, it is represented in the table.

PRN	tle_rise	tle_set	tle_cul	tle_arc_count
G05	14:00:00	14:30:00		1800.0
G08	14:00:00	14:30:00		1800.0
G13	14:00:00	14:30:00		1800.0
G14	14:00:00	14:30:00		1800.0
G15	14:00:00	14:30:00		1800.0
G18				
G20	14:00:00	14:30:00		1800.0
G23	14:00:00	14:30:00		1800.0
G24	14:00:00	14:30:00		1800.0
G28	14:00:00	14:30:00		1800.0
G30	14:00:00	14:30:00		1800.0
G17	14:00:00	14:30:00		1800.0
G11	14:00:00	14:30:00		1800.0
G10	14:00:00	14:30:00		1800.0
G19	14:00:00	14:30:00		1800.0

3.5.2 Navigation signals analysis for GPS NavSTAR

Analysis of navigation signal G1C

1. Figure 7 represents the observed time span for navigation signal G1C set out against the maximum time span calculated from the Two Line Elements (TLE). If present, the culmination point for a satellite is represented by a triangle. The time span from TLEs is represented by the lighter area while the real observations are represented by the dark super-imposed areas.

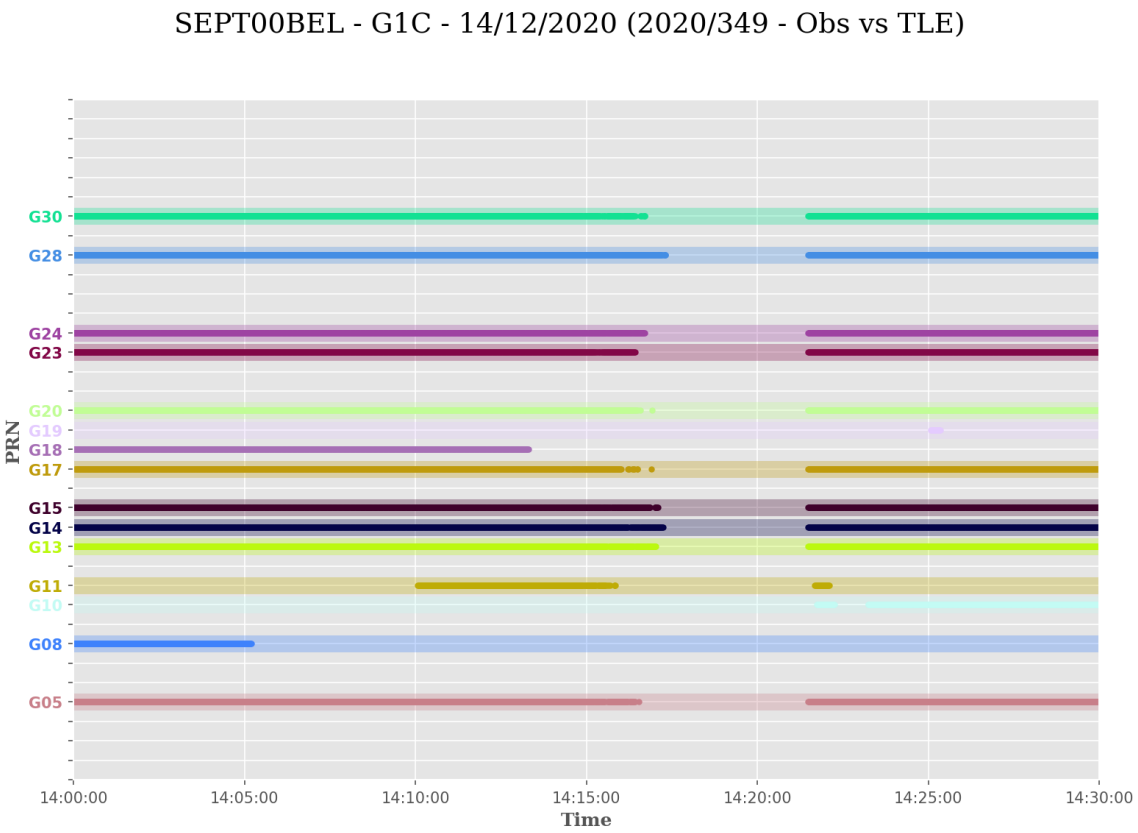


Figure 7: Navigation signal G1C versus TLE time span

2. Figure 8 displays the evolution of observation type S1C.
   The upper plot represents the variation of the observation type while the middle plot (if available) displays the variation of this observable between 2 consecutive epochs. The bottom plot displays the TLE time spans for the satellies.

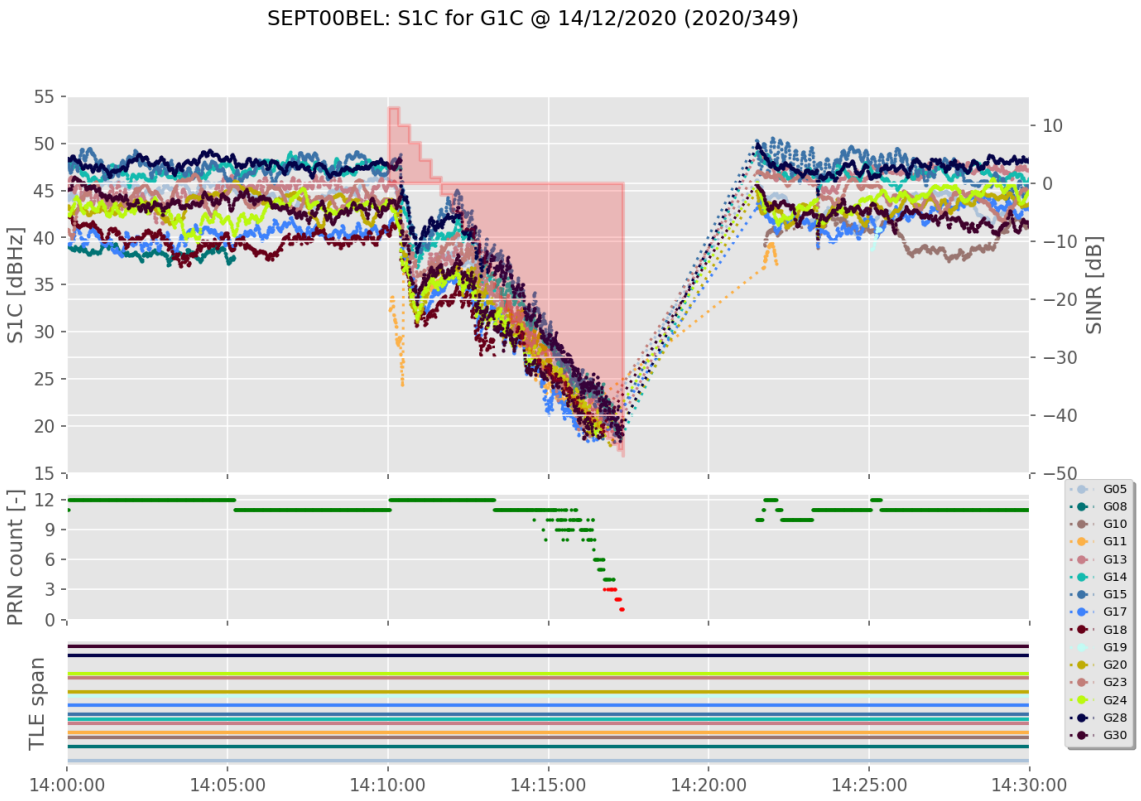


Figure 8: Navigation signal S1C evolution

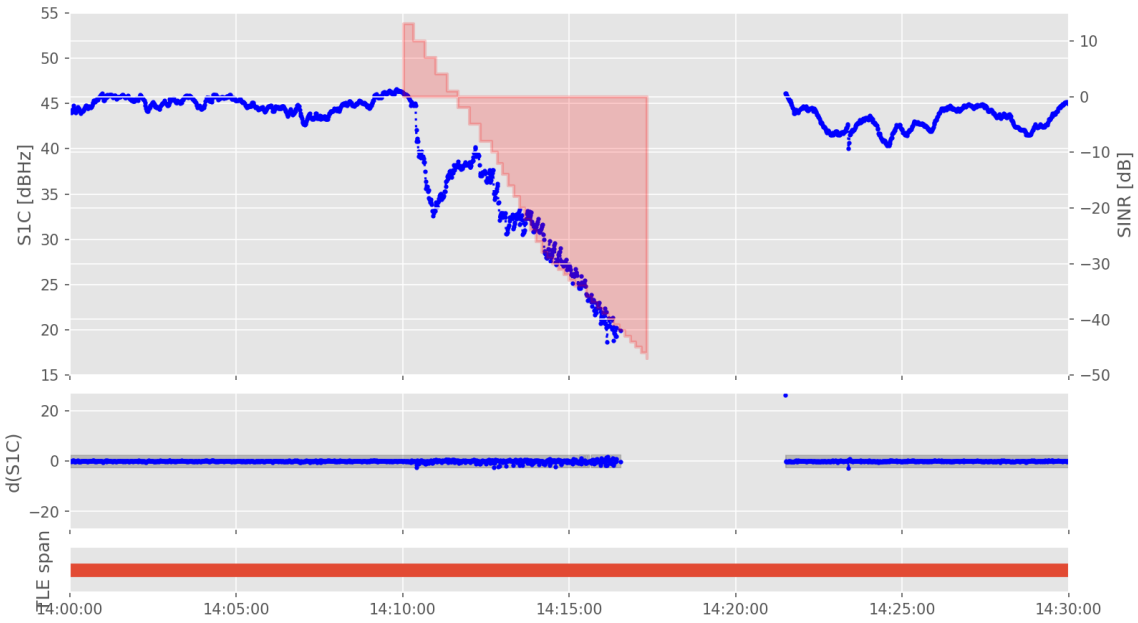
The table below reports the loss and reacquisition of PNT for observable S1C.

Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:16:43	Loss	PNT	2.0	2020-12-14 14:16:45
2020-12-14 14:16:49	Loss	PNT	2.0	2020-12-14 14:16:51
2020-12-14 14:16:52	Loss	PNT	2.0	2020-12-14 14:16:54
2020-12-14 14:16:55	Loss	PNT	5.0	2020-12-14 14:17:00
2020-12-14 14:17:02	Loss	PNT	267.0	2020-12-14 14:21:29

3. Analysis of navigation signal G1C for each observed satellite.
   ewline The following plots display the same information as described above per satellite. Each plot is accompanied by a table displaying the time of loss of lock and reacquisition of the satellite when such events are detected.

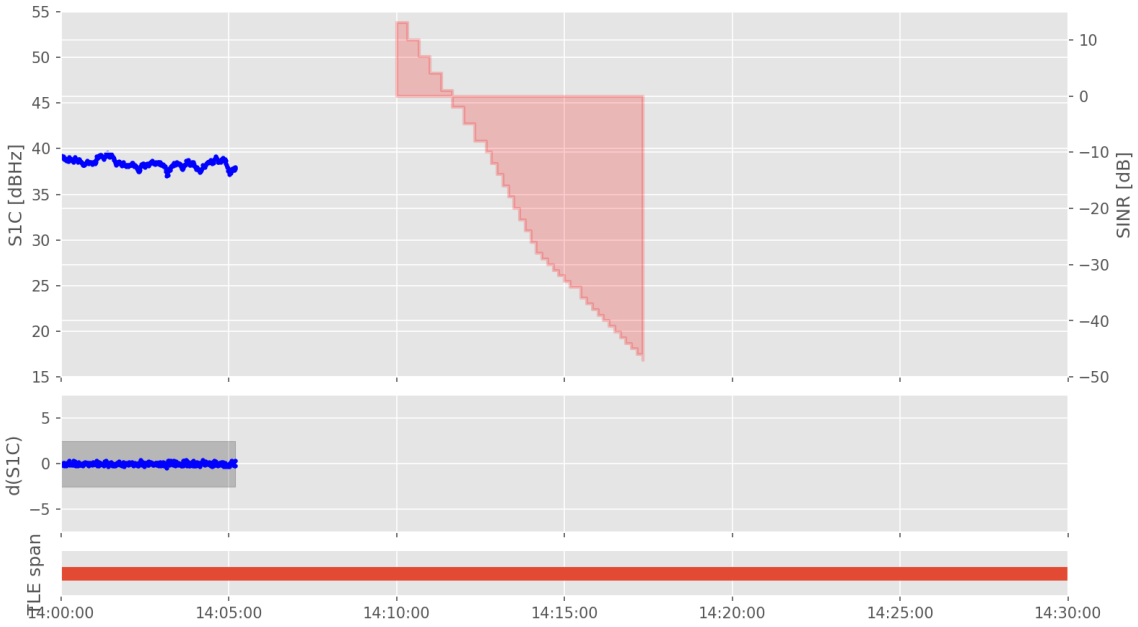
SEPT00BEL: S1C for G05 @ 14/12/2020 (2020/349)



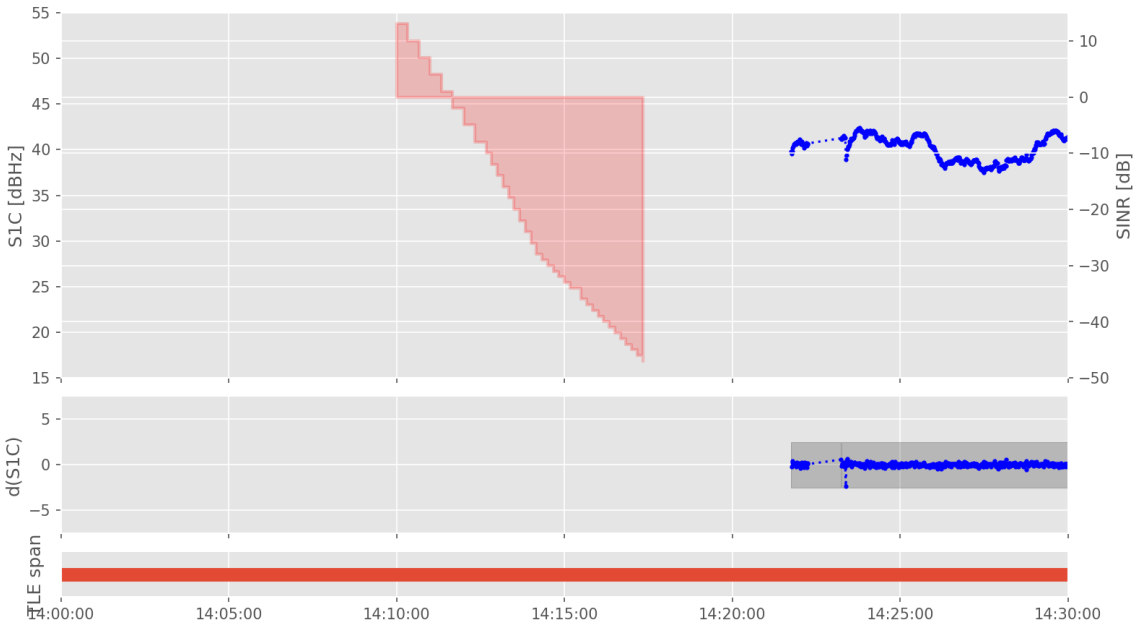
Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:14	Loss	G05	2.0	2020-12-14 14:15:16
2020-12-14 14:15:23	Loss	G05	2.0	2020-12-14 14:15:25
2020-12-14 14:15:26	Loss	G05	2.0	2020-12-14 14:15:28
2020-12-14 14:15:30	Loss	G05	2.0	2020-12-14 14:15:32
2020-12-14 14:15:33	Loss	G05	3.0	2020-12-14 14:15:36
2020-12-14 14:15:36	Loss	G05	2.0	2020-12-14 14:15:38
2020-12-14 14:16:13	Loss	G05	3.0	2020-12-14 14:16:16
2020-12-14 14:16:25	Loss	G05	7.0	2020-12-14 14:16:32
2020-12-14 14:16:32	Loss	G05	297.0	2020-12-14 14:21:29

SEPT00BEL: S1C for G08 @ 14/12/2020 (2020/349)

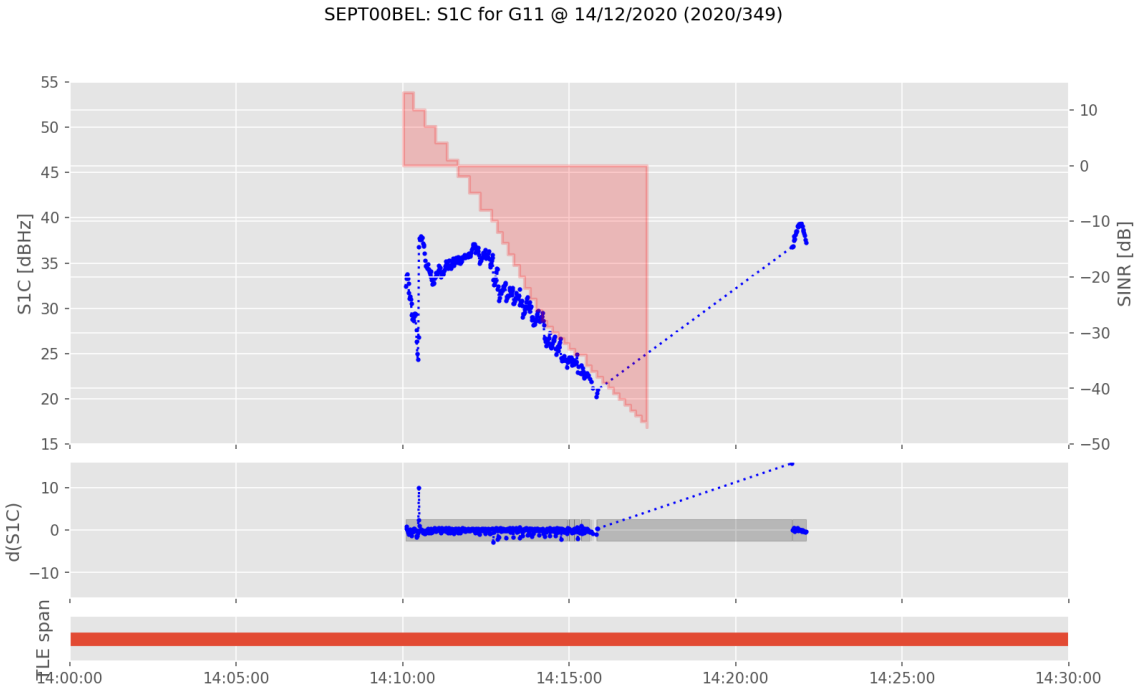


SEPT00BEL: S1C for G10 @ 14/12/2020 (2020/349)



Navigation signal 1C

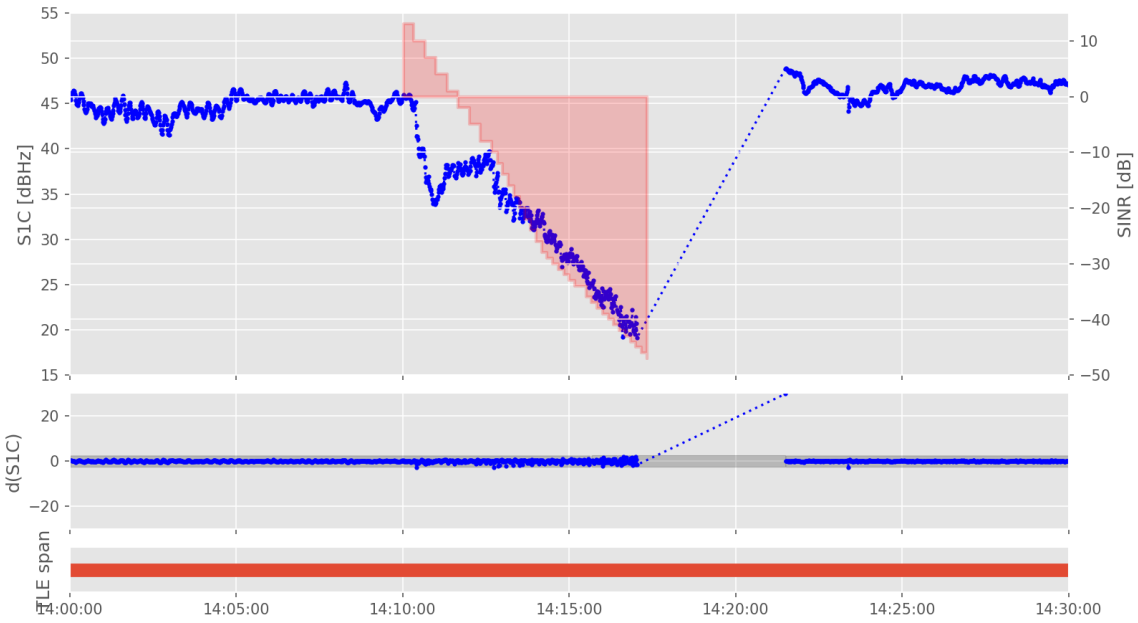
DATE_TIME	event	type	duration	reacq
2020-12-14 14:22:15	Loss	G10	59.0	2020-12-14 14:23:14



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:14:54	Loss	G11	2.0	2020-12-14 14:14:56
2020-12-14 14:14:57	Loss	G11	2.0	2020-12-14 14:14:59
2020-12-14 14:15:06	Loss	G11	2.0	2020-12-14 14:15:08
2020-12-14 14:15:16	Loss	G11	3.0	2020-12-14 14:15:19
2020-12-14 14:15:19	Loss	G11	2.0	2020-12-14 14:15:21
2020-12-14 14:15:34	Loss	G11	3.0	2020-12-14 14:15:37
2020-12-14 14:15:37	Loss	G11	2.0	2020-12-14 14:15:39
2020-12-14 14:15:39	Loss	G11	3.0	2020-12-14 14:15:42
2020-12-14 14:15:42	Loss	G11	7.0	2020-12-14 14:15:49
2020-12-14 14:15:51	Loss	G11	350.0	2020-12-14 14:21:41

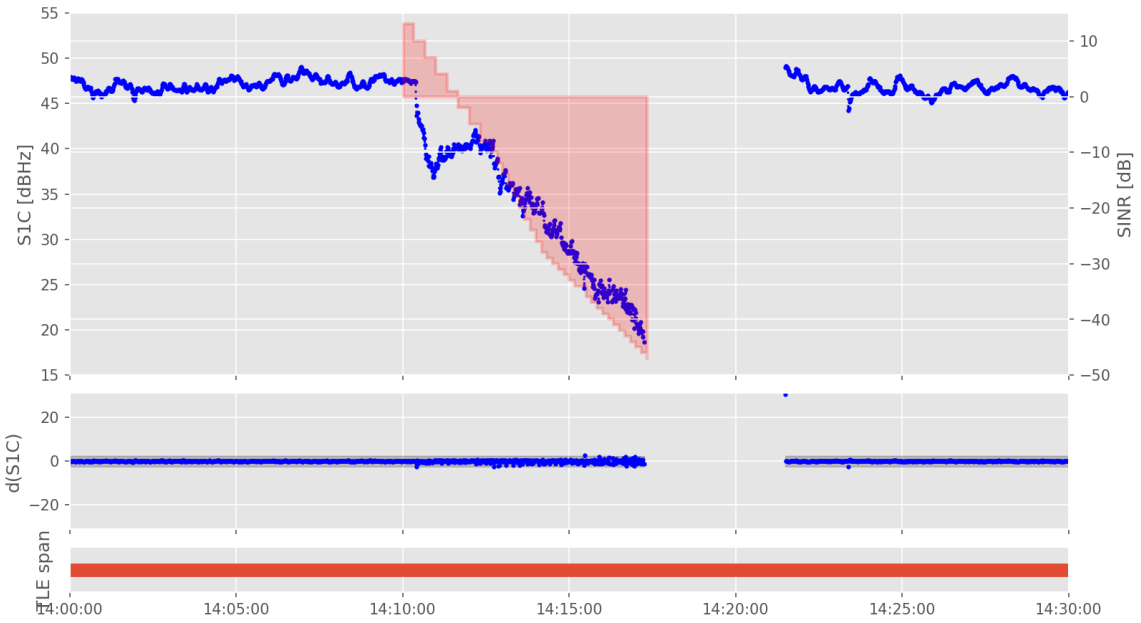
SEPT00BEL: S1C for G13 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:35	Loss	G13	2.0	2020-12-14 14:15:37
2020-12-14 14:15:37	Loss	G13	3.0	2020-12-14 14:15:40
2020-12-14 14:16:23	Loss	G13	3.0	2020-12-14 14:16:26
2020-12-14 14:16:43	Loss	G13	2.0	2020-12-14 14:16:45
2020-12-14 14:17:02	Loss	G13	267.0	2020-12-14 14:21:29

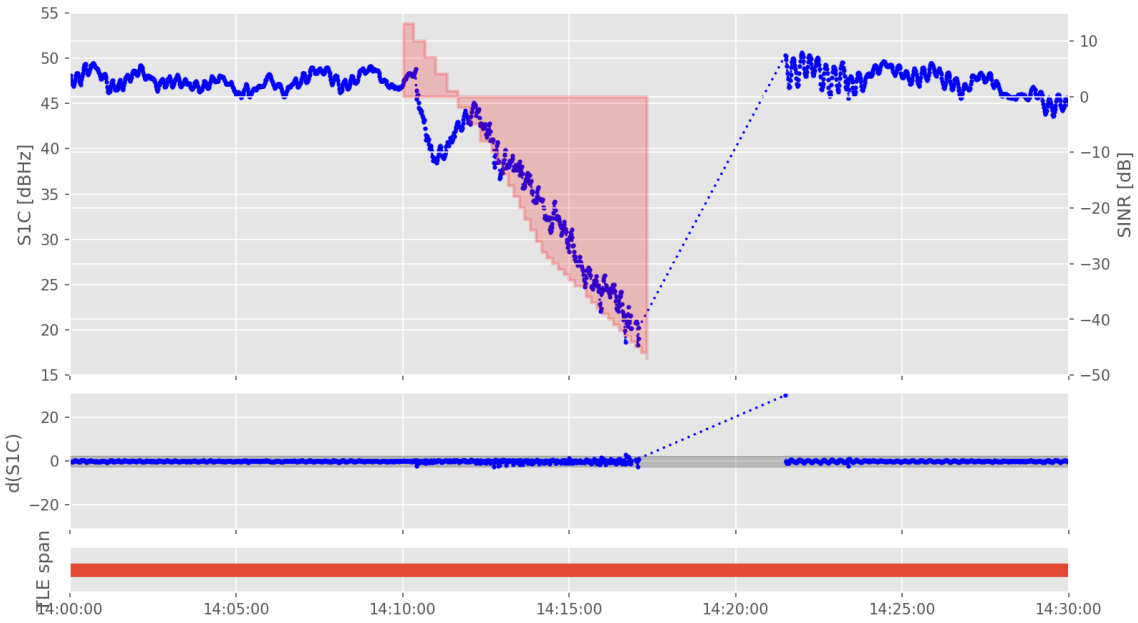
SEPT00BEL: S1C for G14 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:16:13	Loss	G14	4.0	2020-12-14 14:16:17
2020-12-14 14:16:34	Loss	G14	2.0	2020-12-14 14:16:36
2020-12-14 14:17:13	Loss	G14	2.0	2020-12-14 14:17:15
2020-12-14 14:17:15	Loss	G14	254.0	2020-12-14 14:21:29

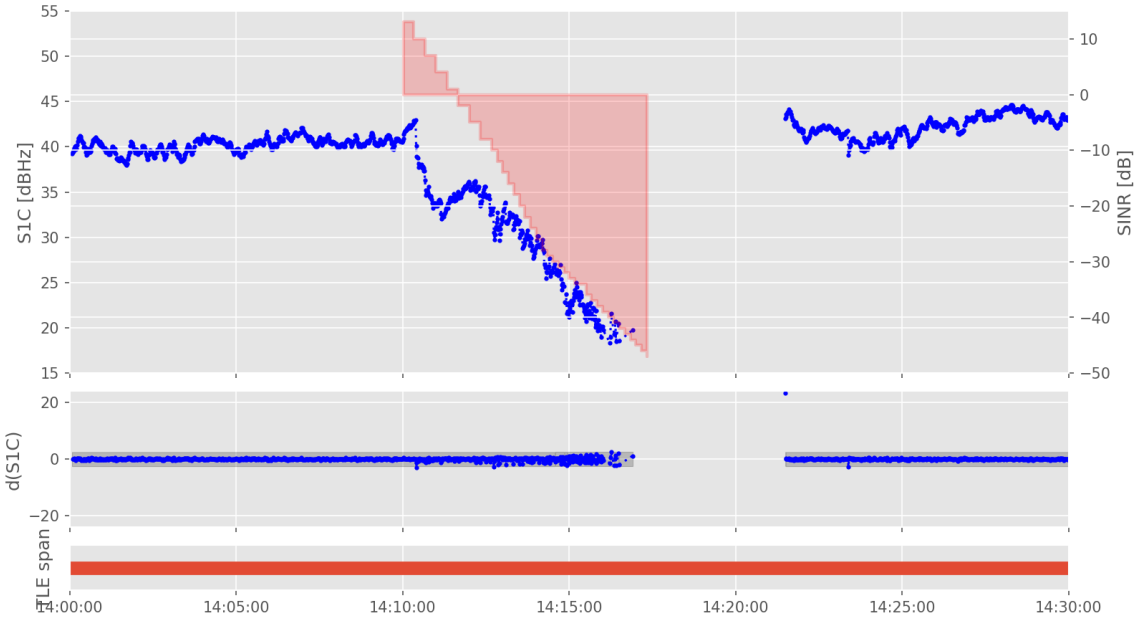
SEPT00BEL: S1C for G15 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:26	Loss	G15	2.0	2020-12-14 14:15:28
2020-12-14 14:15:38	Loss	G15	2.0	2020-12-14 14:15:40
2020-12-14 14:15:42	Loss	G15	2.0	2020-12-14 14:15:44
2020-12-14 14:16:52	Loss	G15	8.0	2020-12-14 14:17:00
2020-12-14 14:17:05	Loss	G15	264.0	2020-12-14 14:21:29

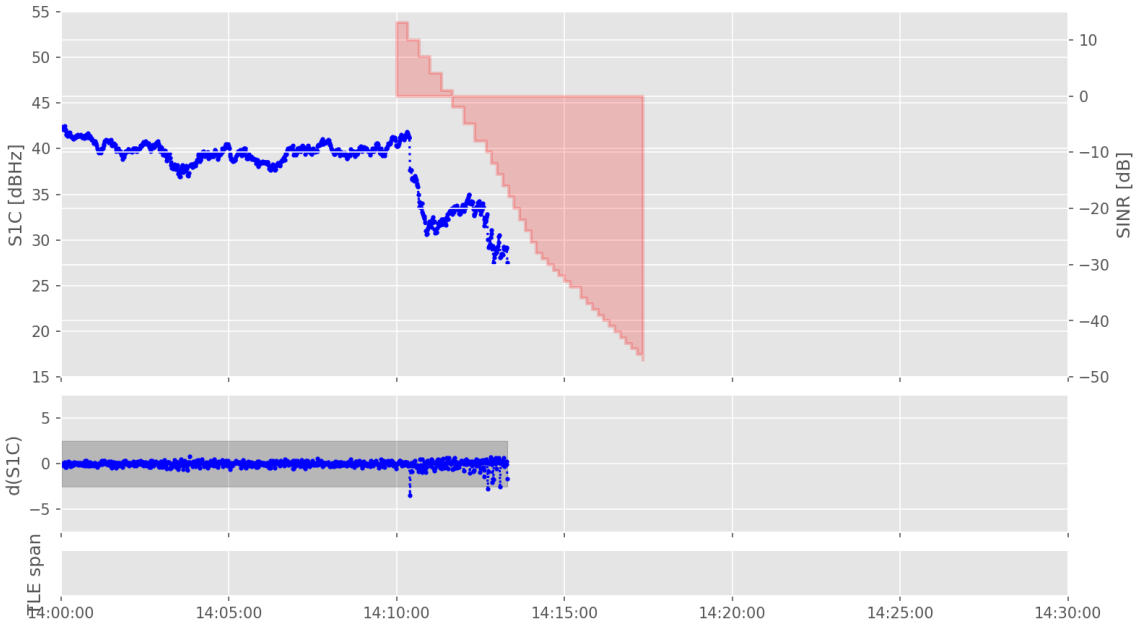
SEPT00BEL: S1C for G17 @ 14/12/2020 (2020/349)



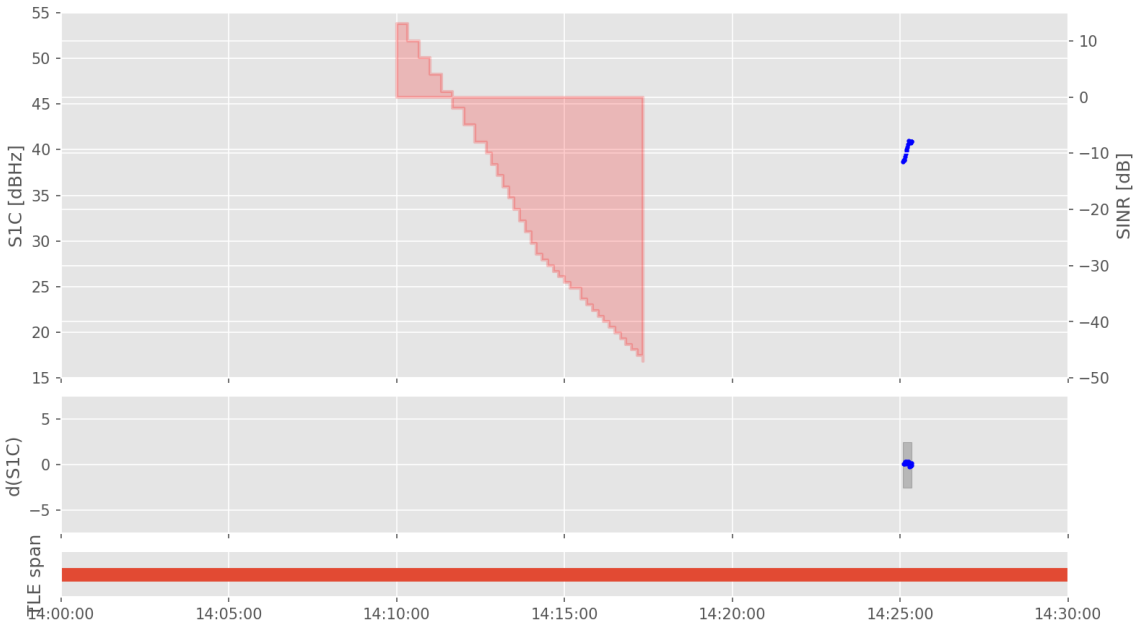
Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:14:32	Loss	G17	2.0	2020-12-14 14:14:34
2020-12-14 14:14:49	Loss	G17	2.0	2020-12-14 14:14:51
2020-12-14 14:14:54	Loss	G17	2.0	2020-12-14 14:14:56
2020-12-14 14:16:01	Loss	G17	12.0	2020-12-14 14:16:13
2020-12-14 14:16:15	Loss	G17	6.0	2020-12-14 14:16:21
2020-12-14 14:16:24	Loss	G17	5.0	2020-12-14 14:16:29
2020-12-14 14:16:30	Loss	G17	24.0	2020-12-14 14:16:54
2020-12-14 14:16:54	Loss	G17	275.0	2020-12-14 14:21:29

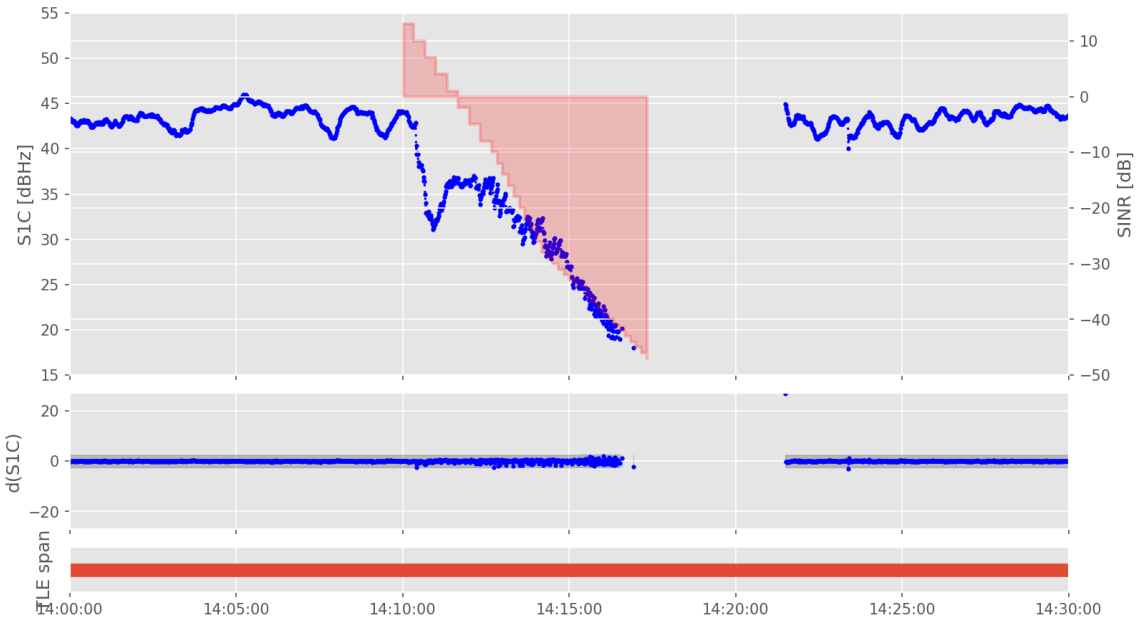
SEPT00BEL: S1C for G18 @ 14/12/2020 (2020/349)



SEPT00BEL: S1C for G19 @ 14/12/2020 (2020/349)



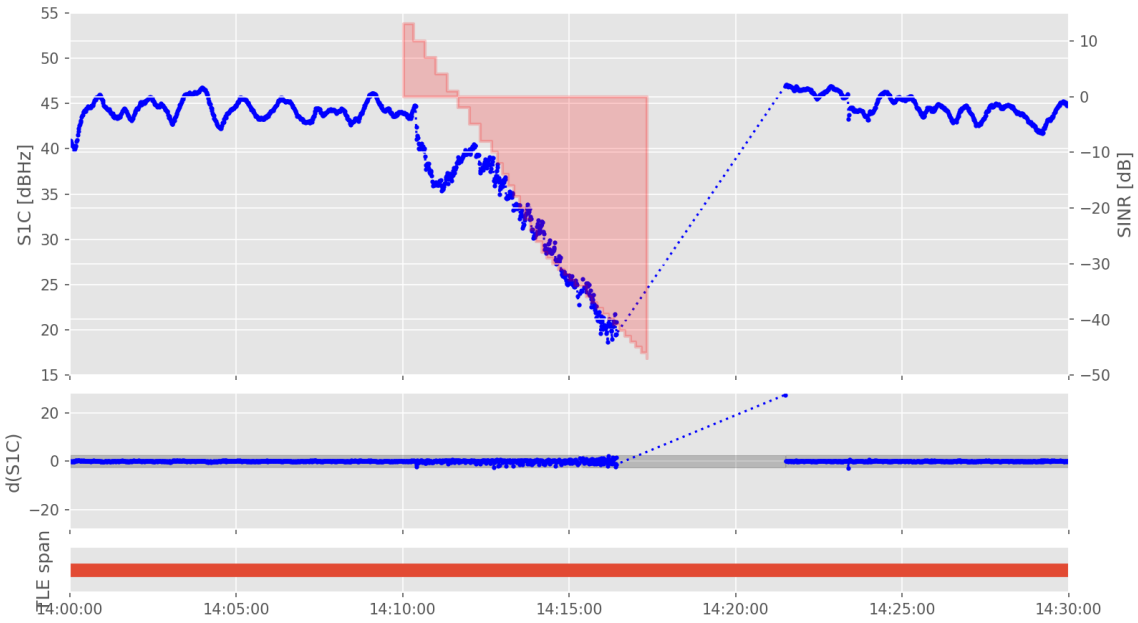
SEPT00BEL: S1C for G20 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:14	Loss	G20	2.0	2020-12-14 14:15:16
2020-12-14 14:15:29	Loss	G20	2.0	2020-12-14 14:15:31
2020-12-14 14:16:23	Loss	G20	2.0	2020-12-14 14:16:25
2020-12-14 14:16:28	Loss	G20	3.0	2020-12-14 14:16:31
2020-12-14 14:16:31	Loss	G20	4.0	2020-12-14 14:16:35
2020-12-14 14:16:35	Loss	G20	20.0	2020-12-14 14:16:55
2020-12-14 14:16:55	Loss	G20	274.0	2020-12-14 14:21:29

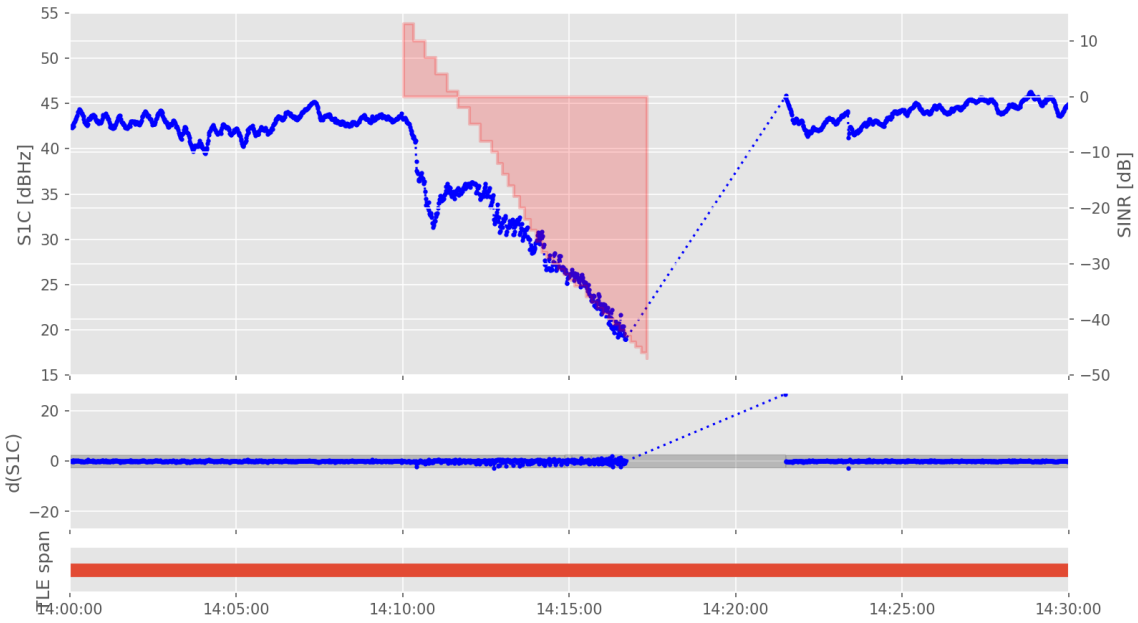
SEPT00BEL: S1C for G23 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:15	Loss	G23	2.0	2020-12-14 14:15:17
2020-12-14 14:15:17	Loss	G23	2.0	2020-12-14 14:15:19
2020-12-14 14:15:19	Loss	G23	2.0	2020-12-14 14:15:21
2020-12-14 14:15:21	Loss	G23	2.0	2020-12-14 14:15:23
2020-12-14 14:15:24	Loss	G23	2.0	2020-12-14 14:15:26
2020-12-14 14:15:26	Loss	G23	2.0	2020-12-14 14:15:28
2020-12-14 14:16:20	Loss	G23	2.0	2020-12-14 14:16:22
2020-12-14 14:16:25	Loss	G23	304.0	2020-12-14 14:21:29

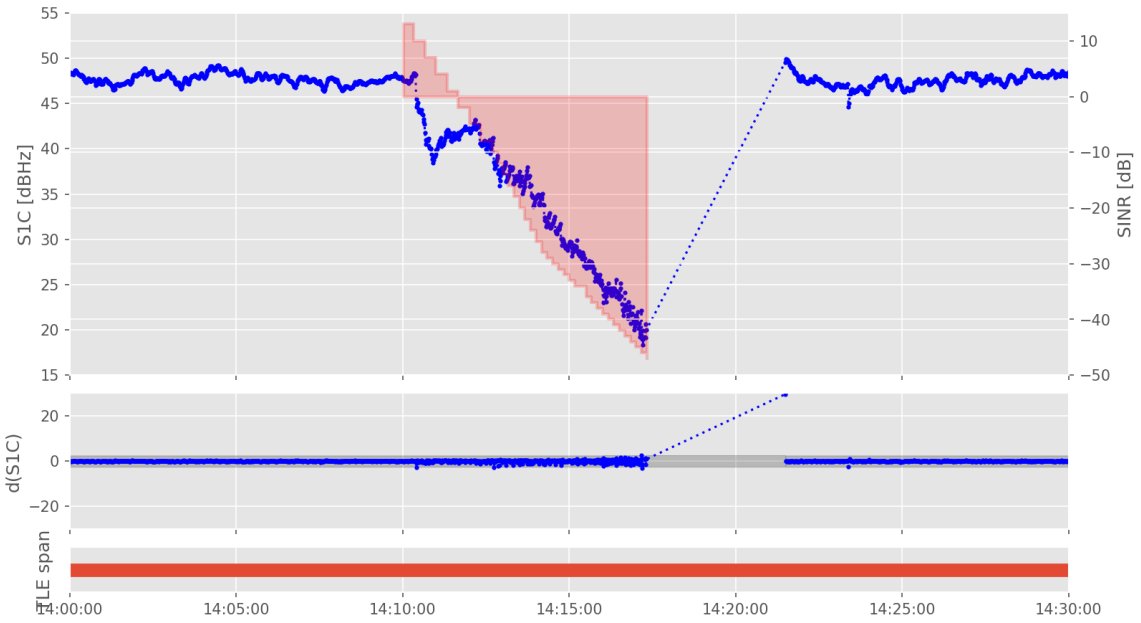
SEPT00BEL: S1C for G24 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:14:49	Loss	G24	2.0	2020-12-14 14:14:51
2020-12-14 14:15:01	Loss	G24	2.0	2020-12-14 14:15:03
2020-12-14 14:15:36	Loss	G24	2.0	2020-12-14 14:15:38
2020-12-14 14:16:19	Loss	G24	2.0	2020-12-14 14:16:21
2020-12-14 14:16:42	Loss	G24	287.0	2020-12-14 14:21:29

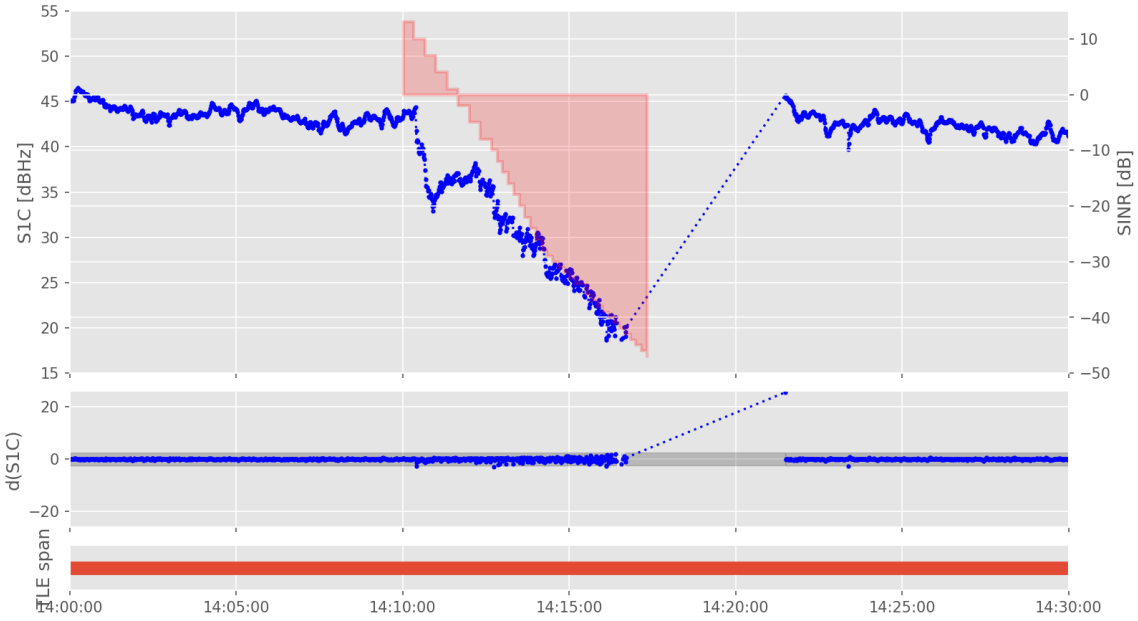
SEPT00BEL: S1C for G28 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:15:59	Loss	G28	2.0	2020-12-14 14:16:01
2020-12-14 14:16:49	Loss	G28	2.0	2020-12-14 14:16:51
2020-12-14 14:17:13	Loss	G28	3.0	2020-12-14 14:17:16
2020-12-14 14:17:19	Loss	G28	250.0	2020-12-14 14:21:29

SEPT00BEL: S1C for G30 @ 14/12/2020 (2020/349)



Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:14:54	Loss	G30	2.0	2020-12-14 14:14:56
2020-12-14 14:15:20	Loss	G30	2.0	2020-12-14 14:15:22
2020-12-14 14:15:24	Loss	G30	3.0	2020-12-14 14:15:27
2020-12-14 14:15:28	Loss	G30	3.0	2020-12-14 14:15:31
2020-12-14 14:15:33	Loss	G30	3.0	2020-12-14 14:15:36
2020-12-14 14:15:44	Loss	G30	2.0	2020-12-14 14:15:46
2020-12-14 14:16:00	Loss	G30	2.0	2020-12-14 14:16:02
2020-12-14 14:16:03	Loss	G30	2.0	2020-12-14 14:16:05
2020-12-14 14:16:18	Loss	G30	2.0	2020-12-14 14:16:20
2020-12-14 14:16:23	Loss	G30	2.0	2020-12-14 14:16:25
2020-12-14 14:16:25	Loss	G30	9.0	2020-12-14 14:16:34
2020-12-14 14:16:34	Loss	G30	2.0	2020-12-14 14:16:36
2020-12-14 14:16:36	Loss	G30	3.0	2020-12-14 14:16:39
2020-12-14 14:16:39	Loss	G30	2.0	2020-12-14 14:16:41

Continued on Next Page

Navigation signal 1C

DATE_TIME	event	type	duration	reacq
2020-12-14 14:16:43	Loss	G30	286.0	2020-12-14 14:21:29

4. Chronological overview of detected events for navigation signal G1C

Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:14:32	Loss	G17	2.0
2020-12-14 14:14:34	Reacquisition	G17	nan
2020-12-14 14:14:49	Loss	G17	2.0
2020-12-14 14:14:49	Loss	G24	2.0
2020-12-14 14:14:51	Reacquisition	G17	nan
2020-12-14 14:14:51	Reacquisition	G24	nan
2020-12-14 14:14:54	Loss	G30	2.0
2020-12-14 14:14:54	Loss	G17	2.0
2020-12-14 14:14:54	Loss	G11	2.0
2020-12-14 14:14:56	Reacquisition	G17	nan
2020-12-14 14:14:56	Reacquisition	G11	nan
2020-12-14 14:14:56	Reacquisition	G30	nan
2020-12-14 14:14:57	Loss	G11	2.0
2020-12-14 14:14:59	Reacquisition	G11	nan
2020-12-14 14:15:01	Loss	G24	2.0
2020-12-14 14:15:03	Reacquisition	G24	nan
2020-12-14 14:15:06	Loss	G11	2.0
2020-12-14 14:15:08	Reacquisition	G11	nan
2020-12-14 14:15:14	Loss	G20	2.0
2020-12-14 14:15:14	Loss	G05	2.0
2020-12-14 14:15:15	Loss	G23	2.0
2020-12-14 14:15:16	Reacquisition	G05	nan
2020-12-14 14:15:16	Reacquisition	G20	nan
2020-12-14 14:15:16	Loss	G11	3.0
2020-12-14 14:15:17	Loss	G23	2.0

Continued on Next Page

Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:15:17	Reacquisition	G23	nan
2020-12-14 14:15:19	Reacquisition	G11	nan
2020-12-14 14:15:19	Loss	G23	2.0
2020-12-14 14:15:19	Reacquisition	G23	nan
2020-12-14 14:15:19	Loss	G11	2.0
2020-12-14 14:15:20	Loss	G30	2.0
2020-12-14 14:15:21	Loss	G23	2.0
2020-12-14 14:15:21	Reacquisition	G11	nan
2020-12-14 14:15:21	Reacquisition	G23	nan
2020-12-14 14:15:22	Reacquisition	G30	nan
2020-12-14 14:15:23	Reacquisition	G23	nan
2020-12-14 14:15:23	Loss	G05	2.0
2020-12-14 14:15:24	Loss	G23	2.0
2020-12-14 14:15:24	Loss	G30	3.0
2020-12-14 14:15:25	Reacquisition	G05	nan
2020-12-14 14:15:26	Loss	G05	2.0
2020-12-14 14:15:26	Loss	G23	2.0
2020-12-14 14:15:26	Loss	G15	2.0
2020-12-14 14:15:26	Reacquisition	G23	nan
2020-12-14 14:15:27	Reacquisition	G30	nan
2020-12-14 14:15:28	Reacquisition	G15	nan
2020-12-14 14:15:28	Loss	G30	3.0
2020-12-14 14:15:28	Reacquisition	G23	nan
2020-12-14 14:15:28	Reacquisition	G05	nan
2020-12-14 14:15:29	Loss	G20	2.0
2020-12-14 14:15:30	Loss	G05	2.0
2020-12-14 14:15:31	Reacquisition	G20	nan
2020-12-14 14:15:31	Reacquisition	G30	nan
2020-12-14 14:15:32	Reacquisition	G05	nan
2020-12-14 14:15:33	Loss	G05	3.0

Continued on Next Page

Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:15:33	Loss	G30	3.0
2020-12-14 14:15:34	Loss	G11	3.0
2020-12-14 14:15:35	Loss	G13	2.0
2020-12-14 14:15:36	Reacquisition	G05	nan
2020-12-14 14:15:36	Loss	G24	2.0
2020-12-14 14:15:36	Reacquisition	G30	nan
2020-12-14 14:15:36	Loss	G05	2.0
2020-12-14 14:15:37	Loss	G11	2.0
2020-12-14 14:15:37	Reacquisition	G13	nan
2020-12-14 14:15:37	Loss	G13	3.0
2020-12-14 14:15:37	Reacquisition	G11	nan
2020-12-14 14:15:38	Reacquisition	G05	nan
2020-12-14 14:15:38	Reacquisition	G24	nan
2020-12-14 14:15:38	Loss	G15	2.0
2020-12-14 14:15:39	Loss	G11	3.0
2020-12-14 14:15:39	Reacquisition	G11	nan
2020-12-14 14:15:40	Reacquisition	G13	nan
2020-12-14 14:15:40	Reacquisition	G15	nan
2020-12-14 14:15:42	Loss	G15	2.0
2020-12-14 14:15:42	Reacquisition	G11	nan
2020-12-14 14:15:42	Loss	G11	7.0
2020-12-14 14:15:44	Loss	G30	2.0
2020-12-14 14:15:44	Reacquisition	G15	nan
2020-12-14 14:15:46	Reacquisition	G30	nan
2020-12-14 14:15:49	Reacquisition	G11	nan
2020-12-14 14:15:51	Loss	G11	350.0
2020-12-14 14:15:59	Loss	G28	2.0
2020-12-14 14:16:00	Loss	G30	2.0
2020-12-14 14:16:01	Loss	G17	12.0
2020-12-14 14:16:01	Reacquisition	G28	nan

Continued on Next Page

Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:16:02	Reacquisition	G30	nan
2020-12-14 14:16:03	Loss	G30	2.0
2020-12-14 14:16:05	Reacquisition	G30	nan
2020-12-14 14:16:13	Reacquisition	G17	nan
2020-12-14 14:16:13	Loss	G14	4.0
2020-12-14 14:16:13	Loss	G05	3.0
2020-12-14 14:16:15	Loss	G17	6.0
2020-12-14 14:16:16	Reacquisition	G05	nan
2020-12-14 14:16:17	Reacquisition	G14	nan
2020-12-14 14:16:18	Loss	G30	2.0
2020-12-14 14:16:19	Loss	G24	2.0
2020-12-14 14:16:20	Reacquisition	G30	nan
2020-12-14 14:16:20	Loss	G23	2.0
2020-12-14 14:16:21	Reacquisition	G24	nan
2020-12-14 14:16:21	Reacquisition	G17	nan
2020-12-14 14:16:22	Reacquisition	G23	nan
2020-12-14 14:16:23	Loss	G20	2.0
2020-12-14 14:16:23	Loss	G30	2.0
2020-12-14 14:16:23	Loss	G13	3.0
2020-12-14 14:16:24	Loss	G17	5.0
2020-12-14 14:16:25	Loss	G23	304.0
2020-12-14 14:16:25	Loss	G05	7.0
2020-12-14 14:16:25	Reacquisition	G30	nan
2020-12-14 14:16:25	Reacquisition	G20	nan
2020-12-14 14:16:25	Loss	G30	9.0
2020-12-14 14:16:26	Reacquisition	G13	nan
2020-12-14 14:16:28	Loss	G20	3.0
2020-12-14 14:16:29	Reacquisition	G17	nan
2020-12-14 14:16:30	Loss	G17	24.0
2020-12-14 14:16:31	Reacquisition	G20	nan

Continued on Next Page

Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:16:31	Loss	G20	4.0
2020-12-14 14:16:32	Loss	G05	297.0
2020-12-14 14:16:32	Reacquisition	G05	nan
2020-12-14 14:16:34	Loss	G30	2.0
2020-12-14 14:16:34	Reacquisition	G30	nan
2020-12-14 14:16:34	Loss	G14	2.0
2020-12-14 14:16:35	Reacquisition	G20	nan
2020-12-14 14:16:35	Loss	G20	20.0
2020-12-14 14:16:36	Reacquisition	G14	nan
2020-12-14 14:16:36	Loss	G30	3.0
2020-12-14 14:16:36	Reacquisition	G30	nan
2020-12-14 14:16:39	Reacquisition	G30	nan
2020-12-14 14:16:39	Loss	G30	2.0
2020-12-14 14:16:41	Reacquisition	G30	nan
2020-12-14 14:16:42	Loss	G24	287.0
2020-12-14 14:16:43	Loss	PNT	2.0
2020-12-14 14:16:43	Loss	G13	2.0
2020-12-14 14:16:43	Loss	G30	286.0
2020-12-14 14:16:45	Reacquisition	G13	nan
2020-12-14 14:16:45	Reacquisition	PNT	nan
2020-12-14 14:16:49	Loss	G28	2.0
2020-12-14 14:16:49	Loss	PNT	2.0
2020-12-14 14:16:51	Reacquisition	PNT	nan
2020-12-14 14:16:51	Reacquisition	G28	nan
2020-12-14 14:16:52	Loss	PNT	2.0
2020-12-14 14:16:52	Loss	G15	8.0
2020-12-14 14:16:54	Loss	G17	275.0
2020-12-14 14:16:54	Reacquisition	PNT	nan
2020-12-14 14:16:54	Reacquisition	G17	nan
2020-12-14 14:16:55	Loss	PNT	5.0

Continued on Next Page

Navigation signal 1C

DATE_TIME	event	type	duration
2020-12-14 14:16:55	Reacquisition	G20	nan
2020-12-14 14:16:55	Loss	G20	274.0
2020-12-14 14:17:00	Reacquisition	PNT	nan
2020-12-14 14:17:00	Reacquisition	G15	nan
2020-12-14 14:17:02	Loss	PNT	267.0
2020-12-14 14:17:02	Loss	G13	267.0
2020-12-14 14:17:05	Loss	G15	264.0
2020-12-14 14:17:13	Loss	G28	3.0
2020-12-14 14:17:13	Loss	G14	2.0
2020-12-14 14:17:15	Reacquisition	G14	nan
2020-12-14 14:17:15	Loss	G14	254.0
2020-12-14 14:17:16	Reacquisition	G28	nan
2020-12-14 14:17:19	Loss	G28	250.0
2020-12-14 14:21:29	Reacquisition	G14	nan
2020-12-14 14:21:29	Reacquisition	G15	nan
2020-12-14 14:21:29	Reacquisition	G13	nan
2020-12-14 14:21:29	Reacquisition	G17	nan
2020-12-14 14:21:29	Reacquisition	G05	nan
2020-12-14 14:21:29	Reacquisition	PNT	nan
2020-12-14 14:21:29	Reacquisition	G20	nan
2020-12-14 14:21:29	Reacquisition	G23	nan
2020-12-14 14:21:29	Reacquisition	G24	nan
2020-12-14 14:21:29	Reacquisition	G28	nan
2020-12-14 14:21:29	Reacquisition	G30	nan
2020-12-14 14:21:41	Reacquisition	G11	nan
2020-12-14 14:22:15	Loss	G10	59.0
2020-12-14 14:23:14	Reacquisition	G10	nan