

# Next BIPM Publication of (UTC - bUTC\_GNSS)

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# Circular T « Section 4 »

Section 4 publishes the difference between  
**UTC**  
and the  
prediction of UTC  
broadcast by GNSS

4 - Relations of UTC and TAI with predictions of UTC(k) disseminated by GNSS.

$$[\text{UTC}-\text{UTC}(\text{USNO})_{\text{GPS}}] = C_0', [\text{TAI}-\text{UTC}(\text{USNO})_{\text{GPS}}] = 37 \text{ s} + C_0'$$

$$[\text{UTC}-\text{UTC}(\text{SU})_{\text{GLONASS}}] = C_1', [\text{TAI}-\text{UTC}(\text{SU})_{\text{GLONASS}}] = 37 \text{ s} + C_1'$$

For this edition of *Circular T*,  $\sigma_0' = 0.9 \text{ ns}$ ,  $\sigma_1' = 7.1 \text{ ns}$

2022	0h UTC	MJD	$C_0'/\text{ns}$	$N_0$	$C_1'/\text{ns}$	$N_1'$
	APR 30	59699	-0.4	89	40.4	87
	MAY 1	59700	-0.5	90	41.1	85
	MAY 2	59701	0.3	89	41.9	83
	MAY 3	59702	-1.3	89	41.9	85
	MAY 4	59703	-3.1	89	42.4	88
	MAY 5	59704	-1.3	89	43.5	87
	MAY 6	59705	-2.0	88	44.9	87
	MAY 7	59706	0.7	87	45.0	86

Date of appearance in Section 4 :  
GPS in 1988 (circular T 12)  
GLONASS in 1990

# Recommendation 2 of the 20th CCTF (2015)

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## ◆ recommends that

Section 5\* of BIPM Circular T be retitled “Relations of UTC and TAI with predictions of UTC disseminated by GNSS”, and adds similar information on new GNSS as they become operational.

\* Now Section 4

<https://www.bipm.org/en/committees/cc/cctf/20-2015/resolution-2>

# New Naming Convention

Introducing new abbreviation: **bUTC<sub>GNSS</sub>**

(GNSS = BDS, GAL, GLO, GPS)

= “*broadcasted prediction of UTC via [GNSS]*”

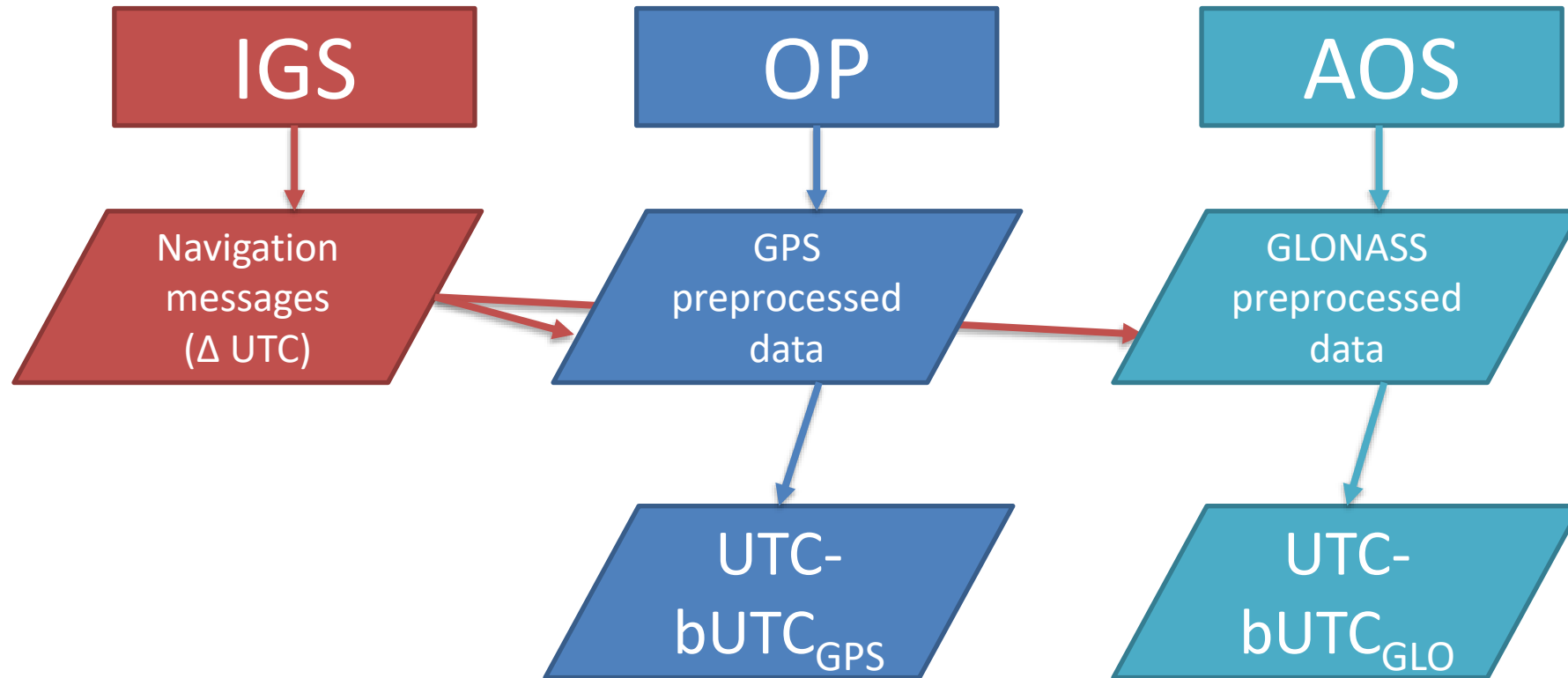
Ascii : bUTC\_GNSS

Which will be computed as :

$$\begin{aligned} UTC - bUTC_{GNSS} = & (UTC - UTC(k)) \quad \leftarrow \text{Comes from Circular T section 1} \\ & + (UTC(k) - GNSStime) \quad \leftarrow \text{Comes from calibrated receivers} \\ & + (GNSStime - bUTC_{GNSS}) \quad \leftarrow \text{G1 labs} \\ & \quad \quad \quad \leftarrow = \Delta UTC, \text{ Comes from GNSS systems through navigation} \\ & \quad \quad \quad \text{messages} \end{aligned}$$

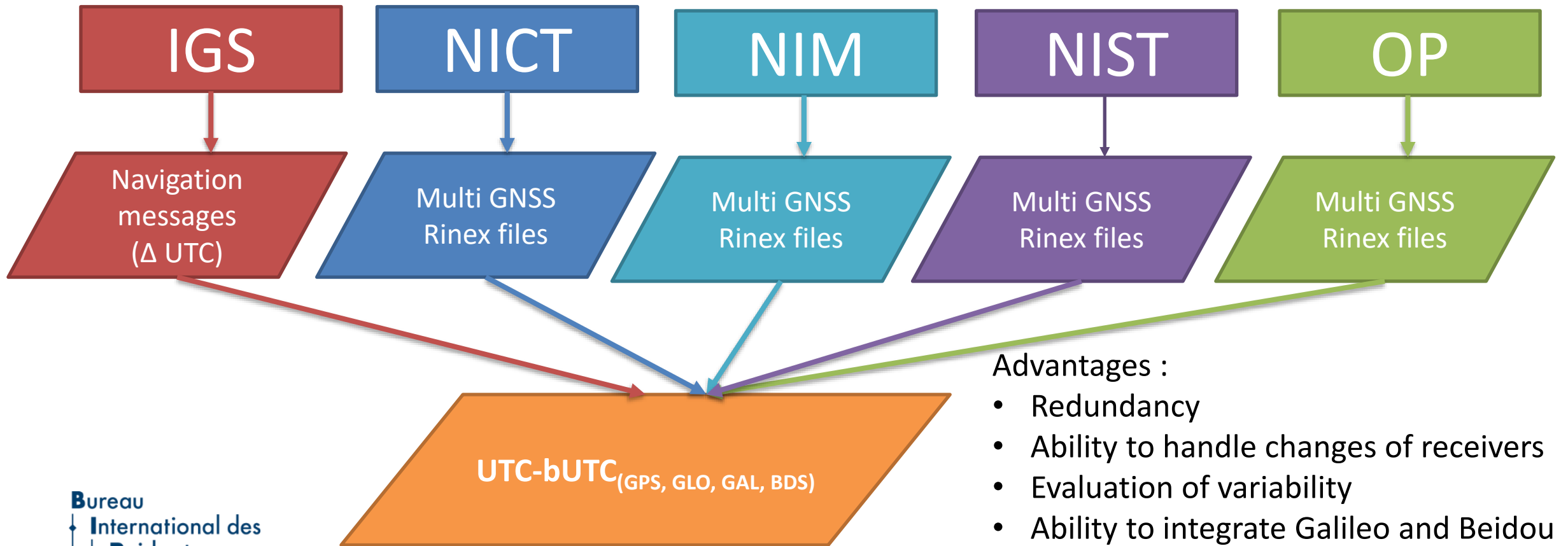
# Current Section 4 Processing Chain

1 lab per GNSS constellation, specific file



# New Section 4 Processing Chain (Metrologia paper published soon)

**Pool** of calibrated G1 labs, regular rinex file, independent  $\Delta$  UTC calculation



Advantages :

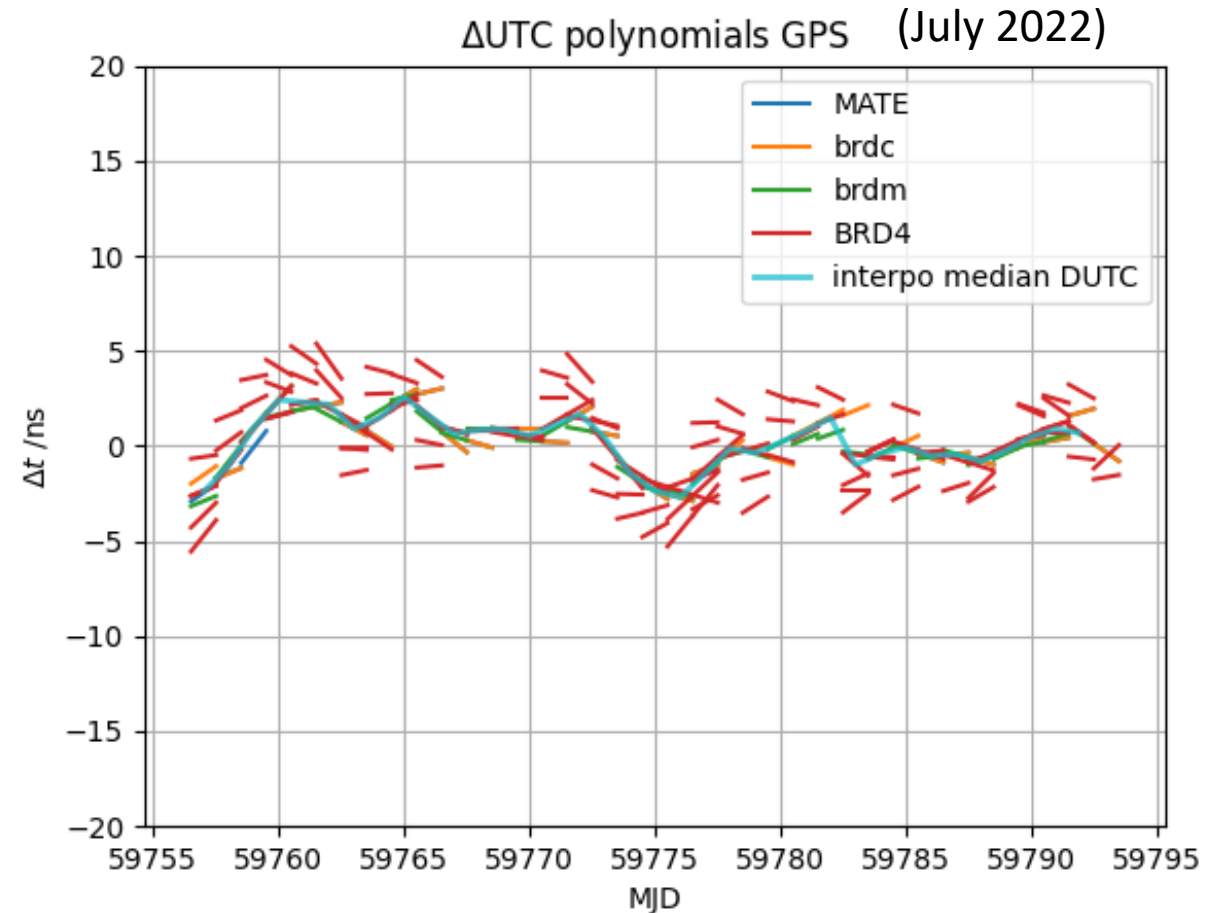
- Redundancy
- Ability to handle changes of receivers
- Evaluation of variability
- Ability to integrate Galileo and Beidou
- New rinex parsing (accepts Rinex 4)

# 1<sup>st</sup> step : $\Delta$ UTC

$\Delta$  UTC = (*GNSStime* – *bUTC<sub>GNSS</sub>*)  
difference between **GNSS system time** and a **UTC prediction realized by the system operator**

Found in Rinex3 nav headers and in Rinex4 nav data (as polynomials).

**Different satellites can broadcast different polynomials, some outliers exist.**



MATE: single receiver (in Matera, Italy), rinex 3

brdc: IGS /CDDIS, rinex 2

brdm: DLR/GSOC, rinex 3

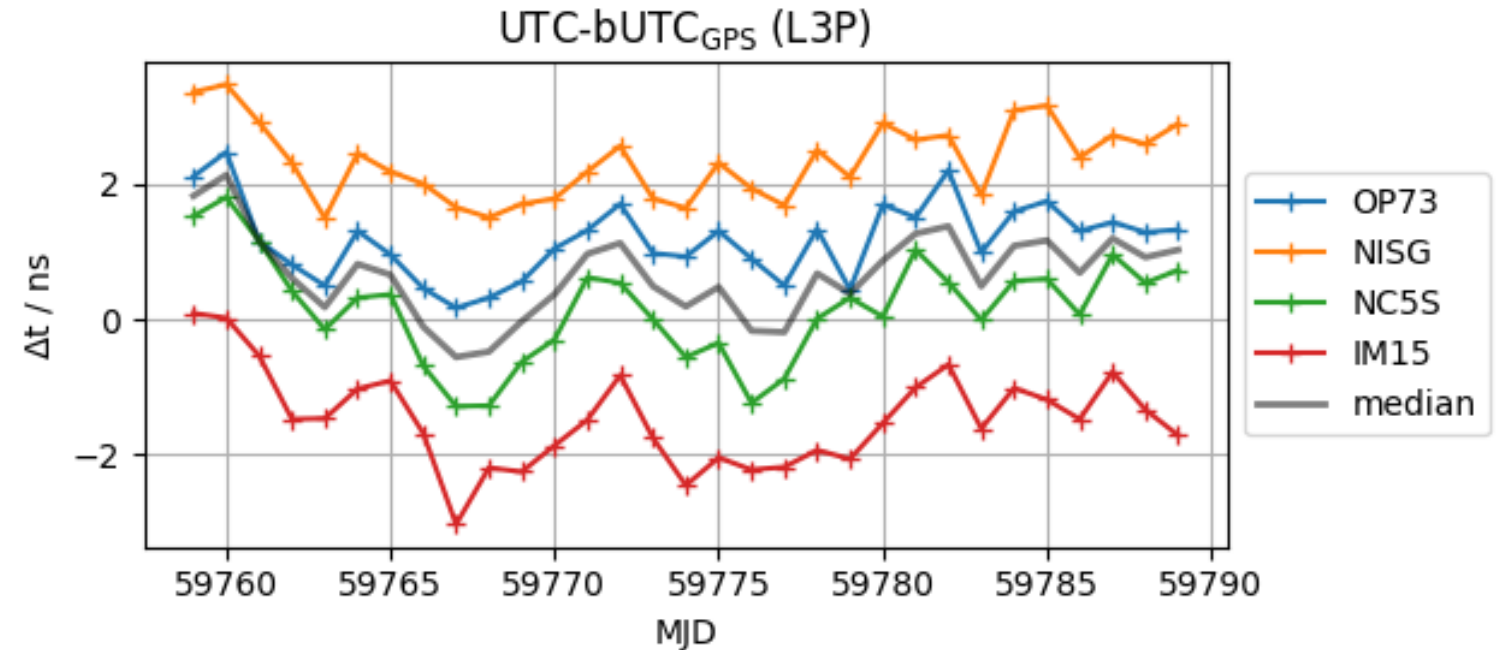
BRD4: DLR/GSOC, rinex 4

# 2<sup>nd</sup> step: UTC - broadcast prediction of UTC ( $bUTC_{GNSS}$ )

$(UTC(k) - GNSStime)$   
 determined by generating  
 CGGTTS files, estimating the  
 REFSYS for each epoch then  
 filter (24h sliding average).

$(UTC - UTC(k))$   
 Interpolated from Circular T  
 section 1.

$$\begin{aligned}
 UTC - bUTC_{GNSS} = & (UTC - UTC(k)) \\
 & + (UTC(k) - GNSStime) \\
 & + (GNSStime - bUTC_{GNSS})
 \end{aligned}$$

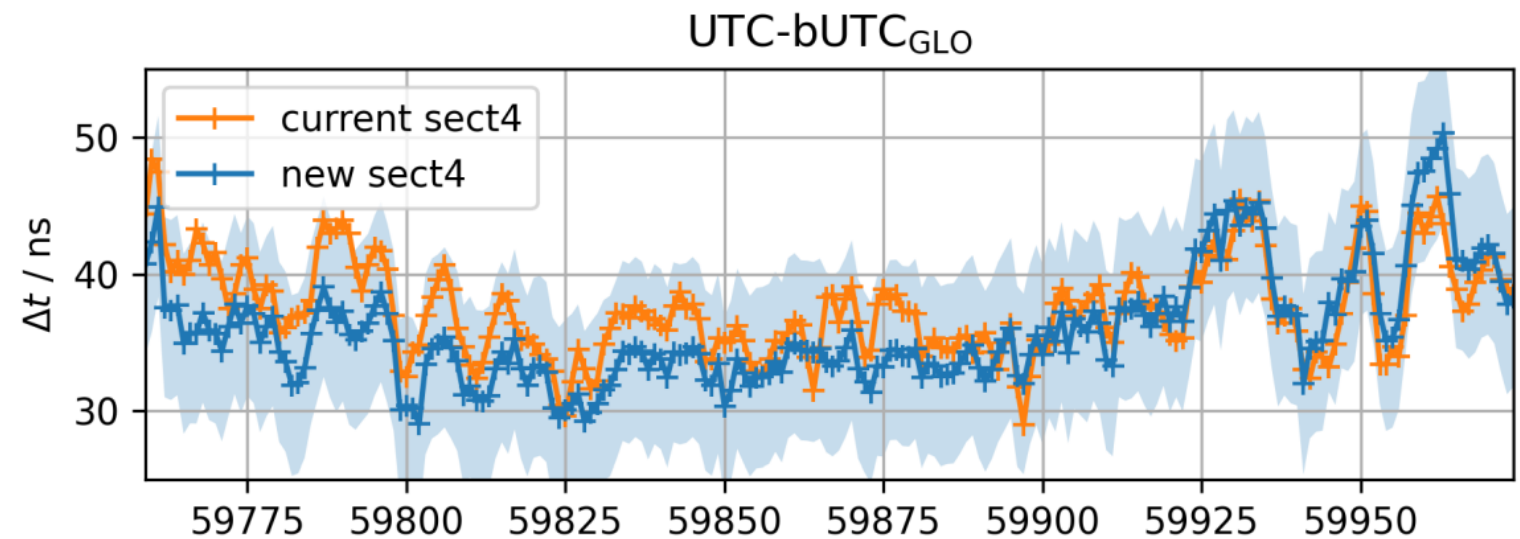
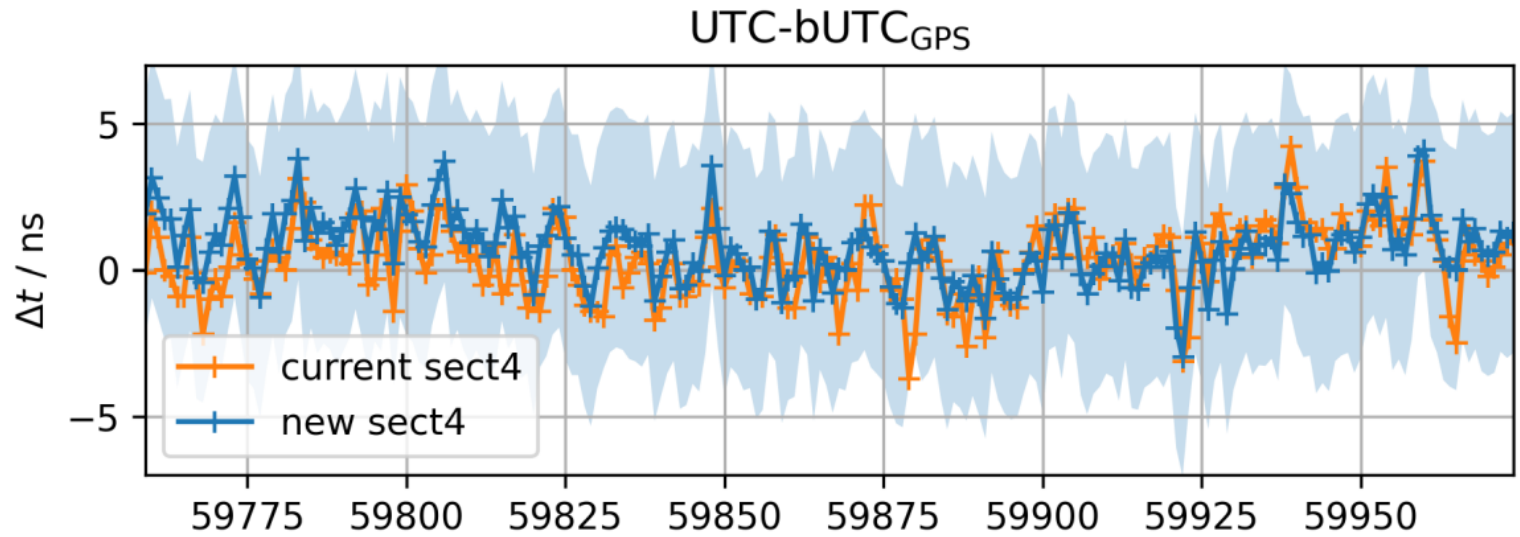




# Comparison with Current Publication over 7 Months

An upcoming Metrologia paper will detail the method.

On these plots : the shaded area visualizes the estimated uncertainty of our measurement, which should not be mistaken for the uncertainty GNSS receiver users may achieve.



# Expected Output (Provisional Version)

4 - Relations of UTC with predictions of UTC broadcast by GNSS.

For this edition of Circular T:

sigma\_GPS = 5 ns  
sigma\_GLO = 7 ns  
sigma\_GAL = 5 ns  
sigma\_BDS = 5 ns

DATE	0h UTC	MJD	UTC-bUTC_GNSS /ns			
			GPS	GLO	GAL	BDS
2023-08-28		60184	1.1	33.8	-5.0	11.1
2023-08-29		60185	0.2	32.0	-4.1	10.4
2023-08-30		60186	0.7	27.8	-3.5	10.6
2023-08-31		60187	1.2	28.2	-2.7	10.7
2023-09-01		60188	2.3	31.9	-2.6	10.9
2023-09-02		60189	3.7	35.2	-1.3	11.4
2023-09-03		60190	1.8	43.1	-1.2	11.4
2023-09-04		60191	2.3	45.2	-0.7	11.7
2023-09-05		60192	0.7	49.7	-0.5	11.8
2023-09-06		60193	1.1	50.4	-0.2	11.8
2023-09-07		60194	2.1	49.8	-0.0	12.2
2023-09-08		60195	1.9	46.0	0.7	12.5
2023-09-09		60196	2.1	46.0	1.0	12.9
2023-09-10		60197	2.2	40.4	0.8	13.7
2023-09-11		60198	1.6	38.2	0.2	14.4
2023-09-12		60199	1.6	37.3	0.2	14.4
2023-09-13		60200	1.2	38.8	-0.5	13.9
2023-09-14		60201	0.7	37.2	-0.2	12.8
2023-09-15		60202	2.3	38.1	1.5	13.3
2023-09-16		60203	2.5	37.7	1.7	13.3
2023-09-17		60204	2.9	37.1	2.0	14.0
2023-09-18		60205	2.5	36.9	1.8	12.5
2023-09-19		60206	2.6	39.3	2.9	13.4
2023-09-20		60207	-0.5	38.7	2.9	13.4
2023-09-21		60208	1.1	41.6	2.2	13.9
2023-09-22		60209	3.0	41.1	1.8	13.6
2023-09-23		60210	2.3	41.5	2.5	11.8
2023-09-24		60211	1.9	40.1	2.7	11.6
2023-09-25		60212	-1.0	39.9	2.5	11.6
2023-09-26		60213	1.6	38.4	2.5	11.6
2023-09-27		60214	3.1	38.5	1.5	10.8

Uncertainty, fixed values.

UTC-bUTC\_GNSS  
1 value per day.

*Thank you for your attention*

