

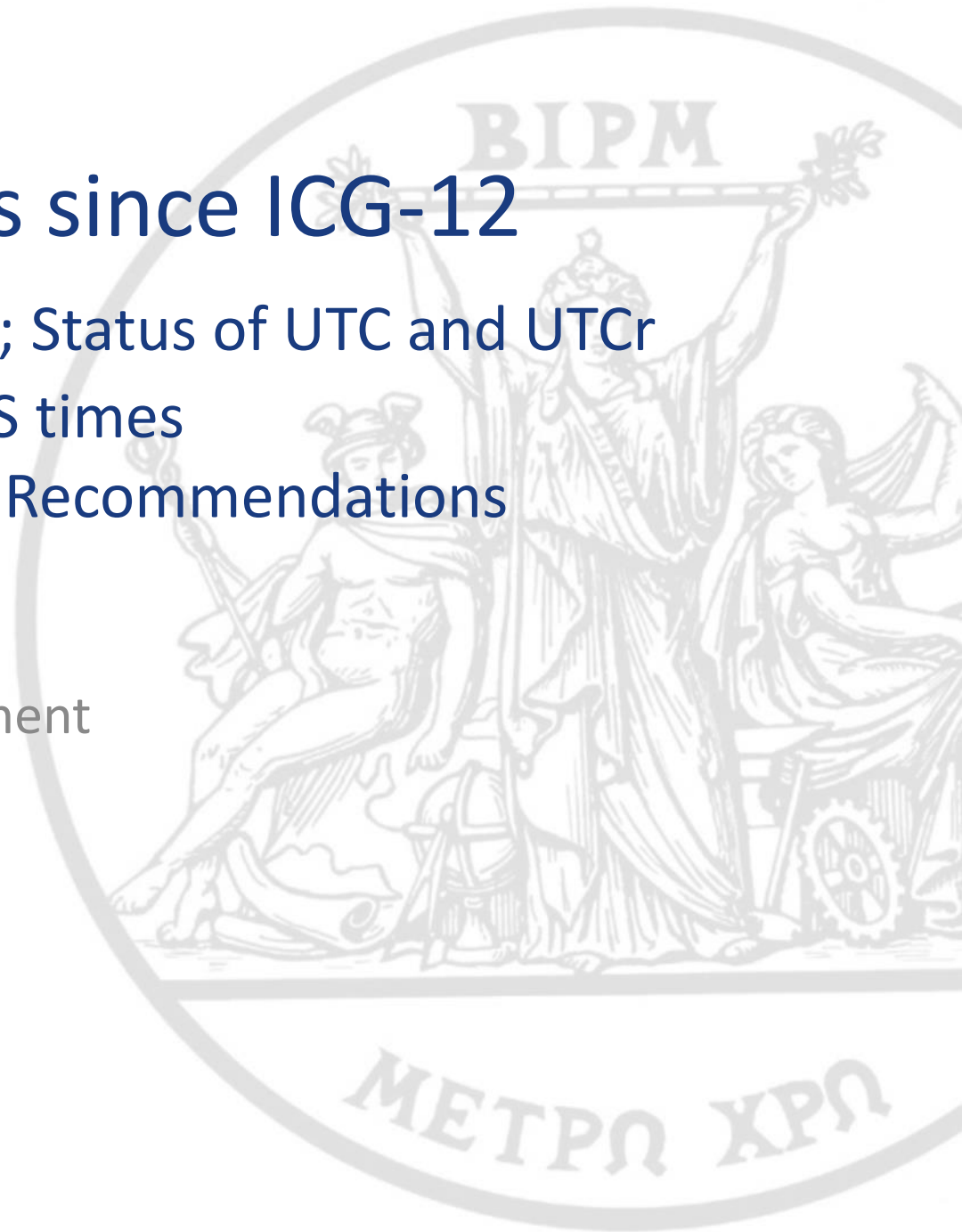
Update of actions since ICG-12

News of the BIPM; Status of UTC and UTCr
Templates of GNSS times
Status of past ICG Recommendations

G. Petit, BIPM Time Department

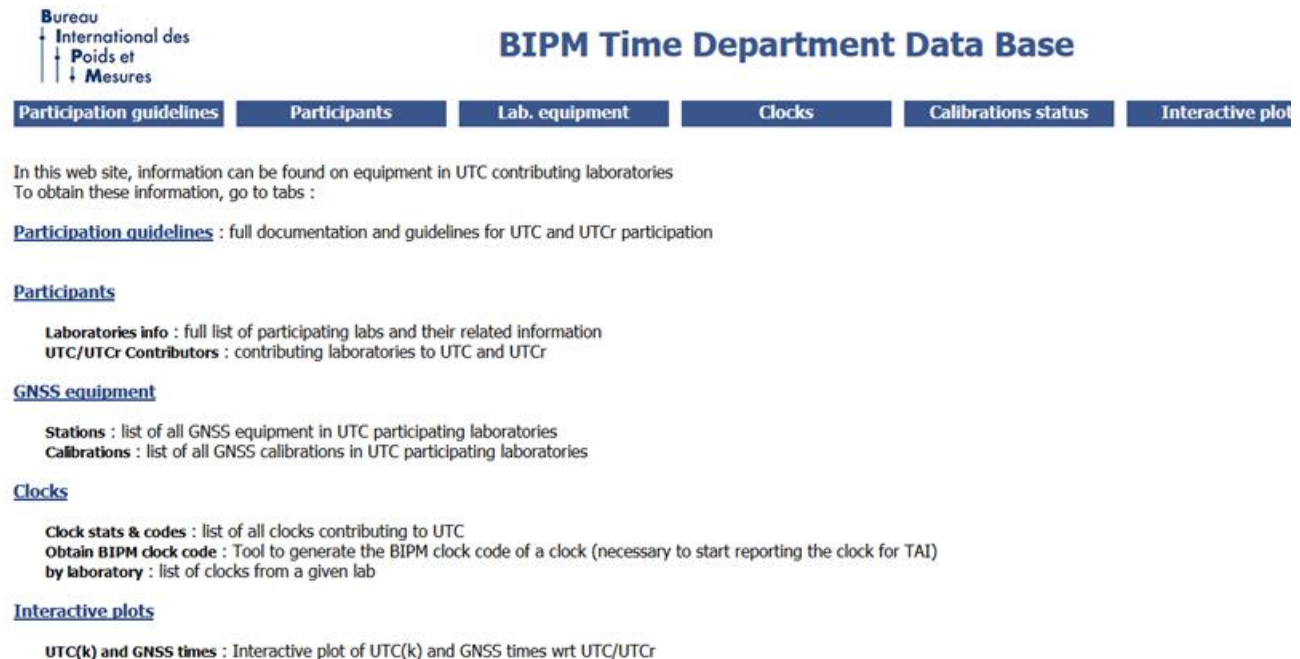
13th ICG Meeting

4-9 November 2018



I. News of the BIPM. Status of UTC and UTCr

- ◆ BIPM Time department staff much renewed (and also decreased): Three out of seven took position in the past two years.
- ◆ Production of UTC and UTCr continues regularly (UTC:80 labs, UTCr:55 labs).
- ◆ Extended access to the information on data and products through the database <http://webtai.bipm.org/database/>



Bureau International des Poids et Mesures

BIPM Time Department Data Base

Participation guidelines | Participants | Lab. equipment | Clocks | Calibrations status | Interactive plots

In this web site, information can be found on equipment in UTC contributing laboratories
To obtain these information, go to tabs :

[Participation guidelines](#) : full documentation and guidelines for UTC and UTCr participation

[Participants](#)

Laboratories info : full list of participating labs and their related information
UTC/UTCr Contributors : contributing laboratories to UTC and UTCr

[GNSS equipment](#)

Stations : list of all GNSS equipment in UTC participating laboratories
Calibrations : list of all GNSS calibrations in UTC participating laboratories

[Clocks](#)

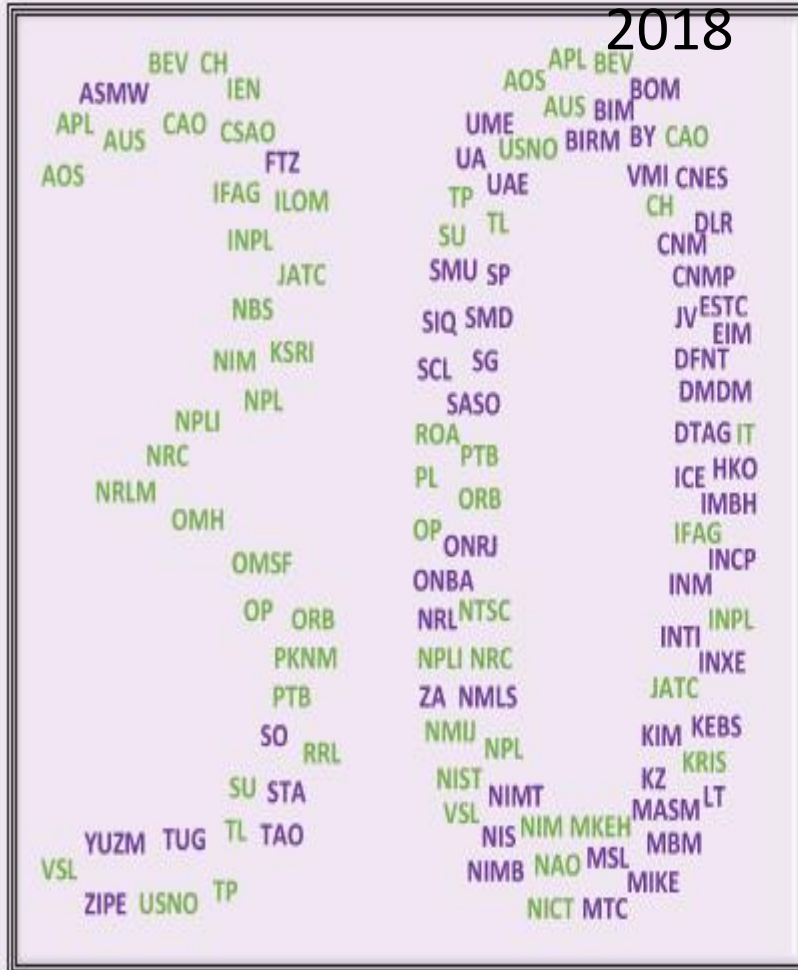
Clock stats & codes : list of all clocks contributing to UTC
Obtain BIPM clock code : Tool to generate the BIPM clock code of a clock (necessary to start reporting the clock for TAI)
by laboratory : list of clocks from a given lab

[Interactive plots](#)

UTC(k) and GNSS times : Interactive plot of UTC(k) and GNSS times wrt UTC/UTCr

CIRCULAR T

March
2018



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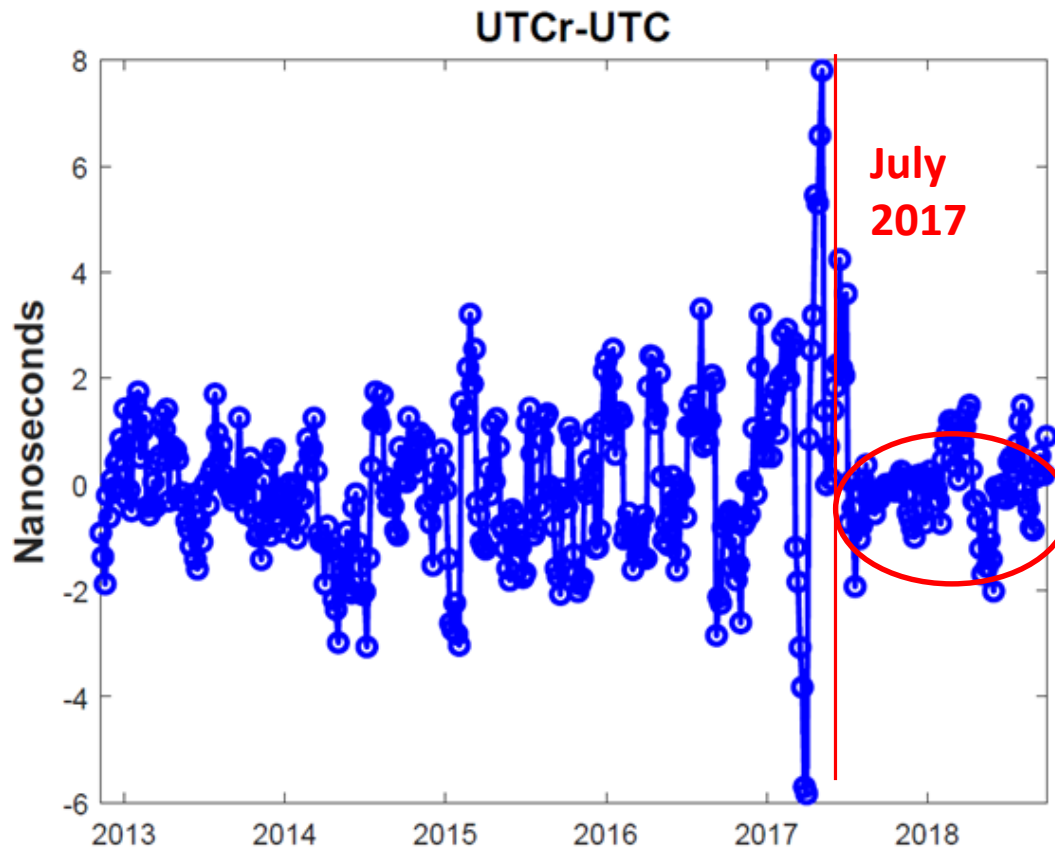
YEARS



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Thank you for your ongoing contributions

Improvement in Rapid UTC (UTCr)



- Uninterrupted weekly publication since July 2013
- ~55 participants
- ~75% of the clocks in UTC

Summer 2017:
New computation procedure to solve problems observed

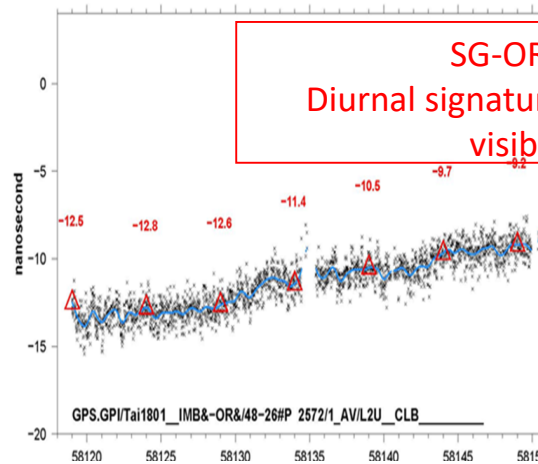
UTCr-UTC now well below 1 ns
RMS, Tdev ~0.4 ns, +/-2 ns p-p.
UTCr easier to extrapolate

First tests on the use of Galileo and BeiDou in UTC

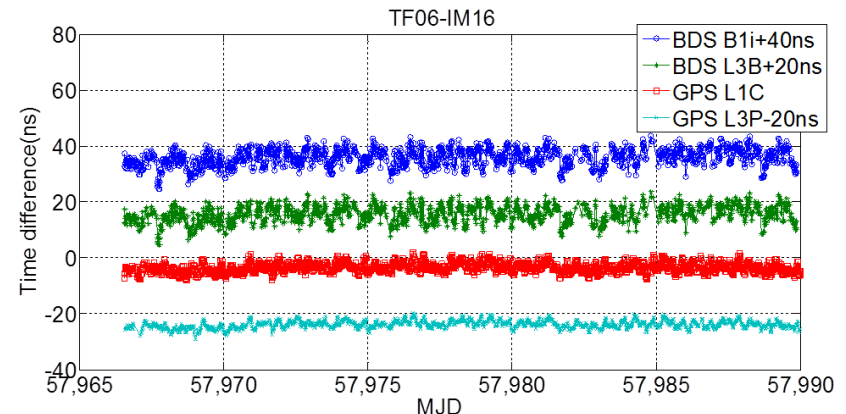
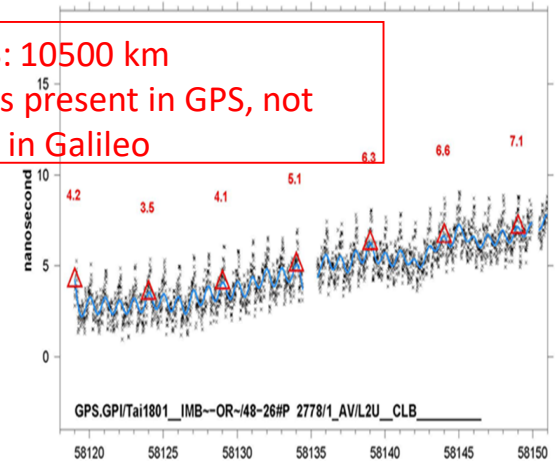
1. time transfer

- ◆ Galileo and BeiDou tests with data from several UTC(k) labs. Comparisons with GPS over several baselines.
- ◆ In “Standard UTC processing” (All-in-view, IGS precise orbits/clocks): Galileo links are at least as good as, or better than, GPS
- ◆ Beidou tests in “Standard UTC processing” under way
- ◆ First results in the frame of a pilot experiment, collaboration between the BIPM and the NIM.

SG-ORB Galileo AV GBM



SG-ORB GPS AV IGS



First tests on the use of Galileo and BeiDou in UTC

2. GNSS times

- ◆ This concerns the provision of $[UTC - GNSS\ time]$ and $[UTC - UTC(k)_{GNSS}]$ for these GNSS, following Rec #20 of the ICG
- ◆ Goal: **Add Galileo and BeiDou to section 4 of Circular T in 2019.**
- ◆ Method in line with what is already done for GPS and GLONASS
 - Use data of one specific receiver in a UTC(k) not directly related to the GNSS under consideration (« typical user »)
 - This receiver should be absolutely calibrated
 - Use receiver data + DUTC in the navigation message to compute $[UTC - UTC(k)_{GNSS}]$
- ◆ Agreement in progress with the European Space Agency for the absolute calibration of a receiver to access Galileo.
- ◆ Agreement with NIM to use an absolutely calibrated BeiDou receiver.

Rec CCTF-3 (2017) Definitions of timescales TAI and UTC

- ◆ Removes ambiguity between TAI and TT that has been present since the IAU redefined TT in 2000. States that the BIPM produces UTC
- ◆ Promote working together on dissemination of UT1-UTC
- ◆ **Should be adopted by the General Conference of Weights and Measures next week.**

decides

- 1- International Atomic Time (TAI) is a continuous time scale produced by the BIPM based on the best realizations of the SI second. TAI is a realization of Terrestrial Time (TT) with the same rate as that of TT, as defined by the IAU Resolution B1.9 (2000),
- 2- Coordinated Universal Time (UTC) is a time scale produced by the BIPM with the same rate as TAI, but differing from TAI only by an integral number of seconds,

and recommends that

- all relevant unions and organizations consider these definitions and work together to develop a common understanding on reference time scales, their realization and dissemination with a view to consider the present limitation on the maximum magnitude of UT1-UTC so as to meet the needs of the current and future user communities,
- all relevant unions and organizations work together to improve further the accuracy of the prediction of UT1-UTC and the method for its dissemination to satisfy the future requirements of the users.

II. Templates of GNSS times

- ◆ Recommendation 11 (2011) on « Finalization and publication of templates on geodetic and timing references »
 - Ongoing, most templates have been published between 2012 and 2016
 - Some templates still need updating; e.g. to be independent of leap second insertion

- ◆ Templates available at <http://www.unoosa.org/oosa/en/ourwork/icg/resources/Regl-ref.html>

Present status of Time templates

GNSS time	Published/updated	Update needed
GPS time	2012	Leap second
GLONASS time	2014	Under way
Galileo System time	Updated 2016	-
EGNOS	2015	-
IGS time	2012	V2 Leap second
BeiDou System time	2016	
QZSS time	2016	
Navic		For 2019

Provision of templates and updates as of 6 November 2018

III. Status of past WG D Recommendations

- ◆ Rec #11 « **Finalization and publication of templates on geodetic and timing references** »
 - Status of templates given above in Part II
- ◆ Rec #16-A « **Information on the works related to the proposed redefinition of UTC** »
 - See above in Part I. Also contribution to the ITU meeting May 2018.
- ◆ Rec #19 « **Official provision of a rapid UTC (UTC_r) by the BIPM** »
 - See above in Part I
- ◆ Rec #20 « **BIPM publication of [UTC – GNSS times] and [UTC – UTC(k)_{GNSS}]** »
 - The BIPM Time Dpt is starting studies to incorporate Galileo and BeiDou data in its analysis for UTC computation. This includes the provision of [UTC – GNSS times] and [UTC – UTC(k)_{GNSS}] for these GNSS.
 - See above in Part I
- ◆ Rec #21 « **On the monitoring of offsets between GNSS times** »
 - See below discussion on GNSS time offsets

Recommendations at ICG-11 and ICG-12 on organizing a workshop to discuss GNSS time offsets among the systems

#21-B: On the monitoring of offsets of GNSS times

- 2017 wording of Recommends 4:

“In order to promote GNSS compatibility and interoperability, GNSS providers and time relevant organizations, including the BIPM, actively develop methods to monitor the offsets between GNSS times, share the monitoring data and relevant research results and actively collaborate with the relevant experts in WG D and S.”

- 2nd Joint timing workshop of WG S and WG D: 20 June 2018
 - Well attended by experts of GNSS providers and time relevant organizations;
 - Several interesting presentations, including new methods to determine the offsets between GNSS times;
 - No clear consensus emerging: Additional work is necessary to assess the accuracy goals for the GNSS time offsets, and consequently the methods to determine them;
- Work stemming from Recommendation 21B should continue.

Common session WG S and D on interoperability (6 Nov 14h)

- ◆ How to determine GNSS time offsets?
- ◆ Several presentations studying one or several of up to five solutions
 - Determination at user level
 - xGTO concept (reference is some average of GNSS times)
 - Use a new timescale MGET as a reference
 - Use the already broadcast « prediction of UTC» as a reference
 - Use (an extrapolation of) UTCr as a reference, as envisioned in Recommendation 19
- ◆ Discussion: need for further studies. No clear way towards a consensus.
- ◆ The idea is to hold a “focused workshop” with limited participation. The providers should first answer to a set of general questions to base the discussion.