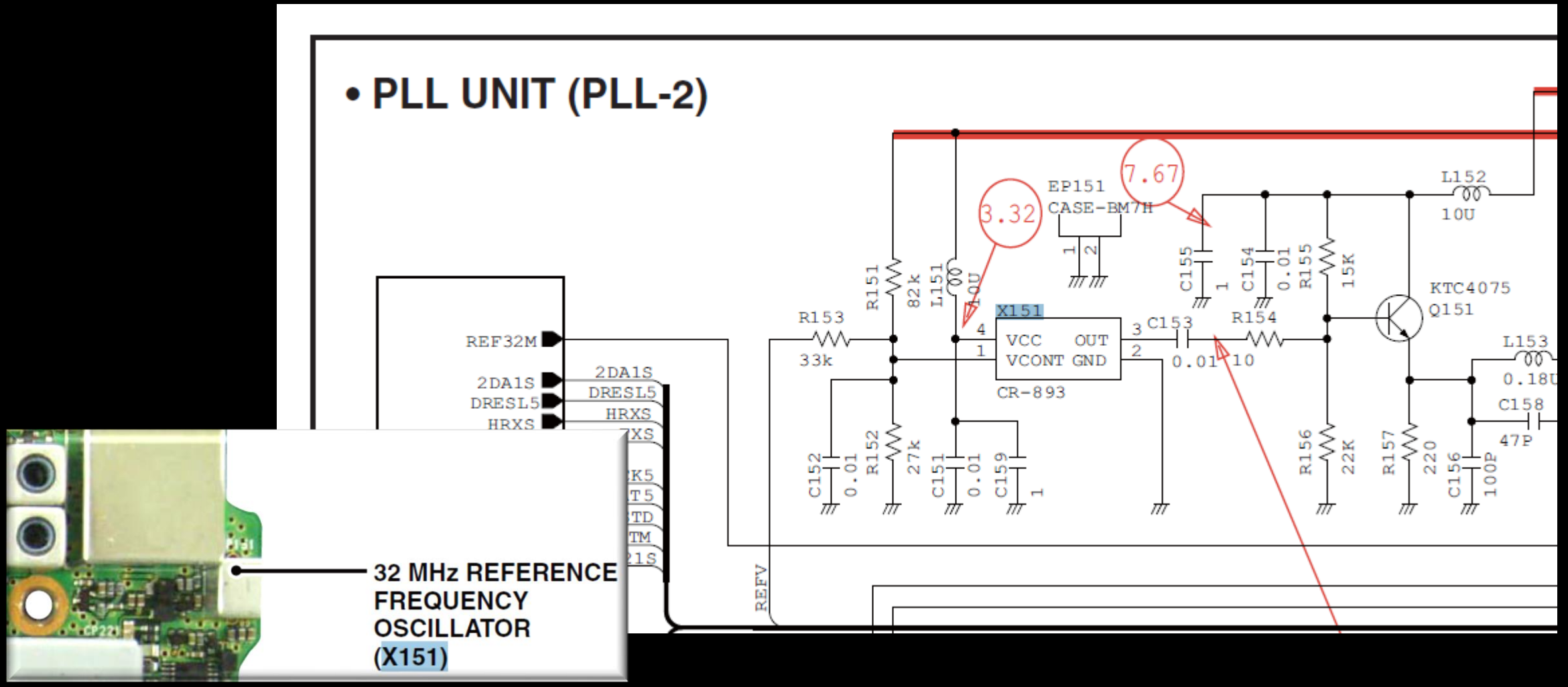
Frequentie

Staat mijn zend/ontvanger goed op Frequentie?

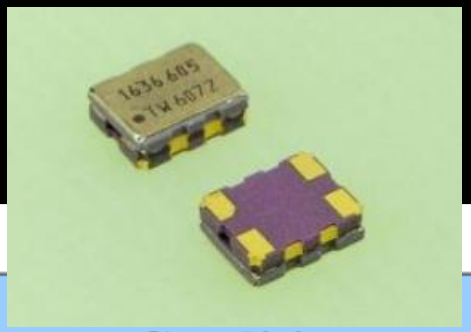
Referentie oscillator in de ICOM IC-9100



Referentie oscillator in de ICOM IC-9100

Nauwkeurigheid 2.0 x 10^{-6}

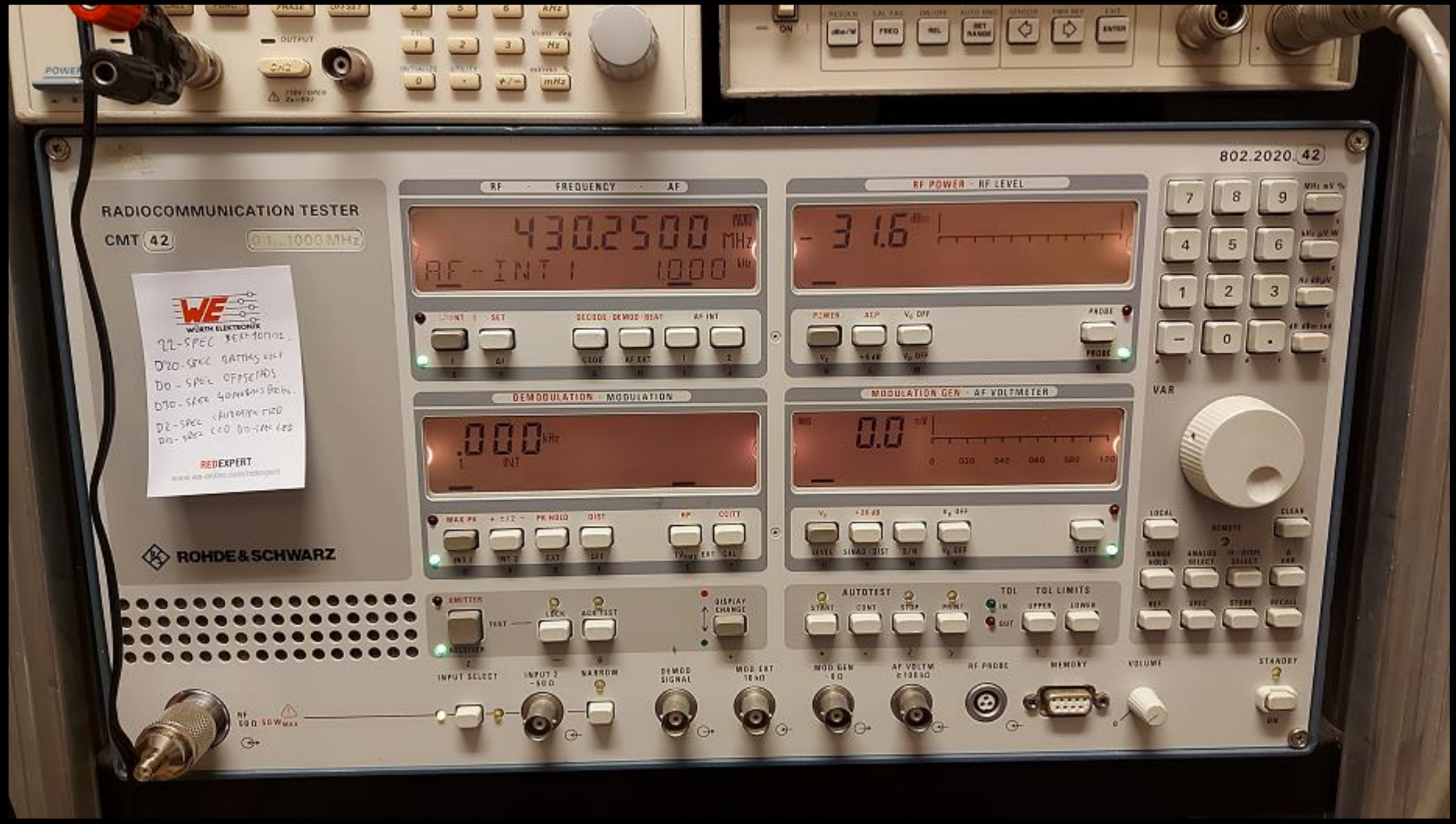
Max Fout = 20 Hz op 10 MHz



♦ **Specifications**

Item	Symbol	Specifications		Conditions
		TTS18NSH (TCXO)	TTS18VSH (VC-TCXO)	
Output frequency	f_0	10.0 MHz to 40.0 MHz		
Supply voltage	Vcc	+2.3V to +3.7V		
Current consumption	Icc	2.0 mA max.		Vcc=3.0V , 10 kOhm//10 pF
Output voltage	Vpp	0.8 V min.		NOTE 1) DC coupling
Load	Load_R,C	10 kOhm // 10 pF		
Frequency Stability				
/Frequency tolerance	f_tol	± 2.0×10^{-6} max.		After reflow , at 25 °C

Icom 9100 wordt gecontroleerd met de Rohde & Schwarz CMT42



Referentie oscillator in de CMT-42

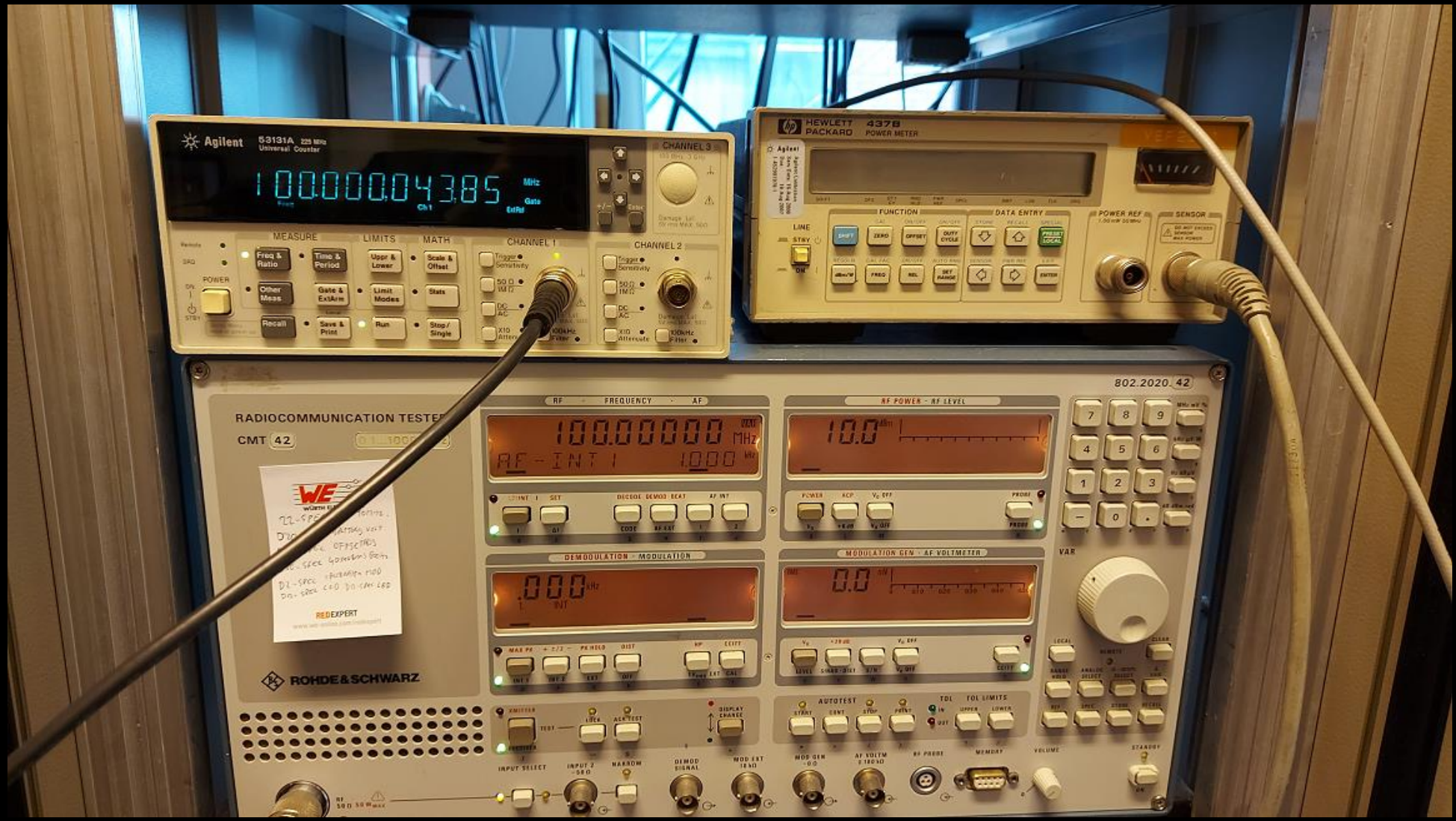
Nauwkeurigheid 5 x 10^{-9}

Max Fout = 0.05 Hz op 10 MHz

High Stabillity Option.

Staat de CMT-42 wel goed op frequentie?

CMT-42 wordt gekalibreerd met Agilent 53131A



Referentie oscillator in de 53131A

Nauwkeurigheid 5 x 10^{-10}

Max Fout = 0.005 Hz op 10 MHz

Time base

Internal time base stability (see graph 3 for timebase contribution of measurement error).

		Standard (0 to 50 °C)	Medium oven (Option 001)	High oven (Option 010)
Temperature stability (referenced to 25°C)		< 5 x 10^{-6}	< 2 x 10^{-7}	< 2.5 x 10^{-9}
Aging rate (after 30 days)	Per day		< 4 x 10^{-8}	< 5 x 10^{-10}
	Per month	< 3 x 10^{-7}	< 2 x 10^{-7}	< 1.5 x 10^{-8}
	Per year			
Turn-on stability vs. time (in 30 minutes)			< 2 x 10^{-7} referenced to 2 h	< 5 x 10^{-9} referenced to 24 h
Calibration		Manual adjust	Electronic	Electronic

Staat de Frequentie Counter wel goed?

De 53131A wordt gekalibreerd met een Rubidium Frequentie Standaard

De Rubidium Frequentie Standaard wordt gekalibreerd bij een Kalibratie Laboratorium

CERTIFICATE OF CALIBRATION

On behalf of:

Instrument: Rubidium Frequency standard

manufacturer	Crowntech
type	LPRO101
serial number	35749
identification	CSE1079
asset number	210001145

Calibration method: The instrument was switched on at day1, 12:00 UTC.
The instrument was allowed to acclimatize 1 day before any measurement was made.

Frequency was measured using a High Resolution Counter locked to a GPS disciplined Rubidium frequency standard.
Measurements have been made from 2021 October, 22 (day 2) to 2021 October, 28 at 12:00 UTC.
Reported frequencies are the average of 25 samples, measured with 100 s gate time.

De Rubidium Frequentie Standaard goed?

Onzekerheidheid 1.9 x 10^{-10}

Max Fout = 0.0019 Hz op 10 MHz

Kiwa Dare Services
Calibrations

Vijzelmolenlaan 7
3447 GX Woerden
The Netherlands

Tel. 0348 200 950
www.dare.nl
calibrations@dare.nl

1. Frequency, '10 MHz' output

Date:	Day number, from switch on:	Average measured frequency:	Allan deviation: $\sigma y(\tau)$	Error ± uncertianty:	Gate time: τ
2021-10-22	2	9,99999999737 MHz	38 µHz	(2,6 ± 1,9) mHz	100 s
2021-10-25	5	9,99999999783 MHz	33 µHz	(2,2 ± 1,9) mHz	100 s
2021-10-26	6	9,99999999791 MHz	50 µHz	(2,1 ± 1,9) mHz	100 s
2021-10-28	8	9,99999999813 MHz	38 µHz	(1,9 ± 1,9) mHz	100 s

Hoe kalibreert een Laboratorium?

Calibration method:	The instrument was switched on at day1, 12:00 UTC. The instrument was allowed to acclimatize 1 day before any measurement was made. Frequency was measured using a High Resolution Counter locked to a GPS disciplined Rubidium frequency standard. Measurements have been made from 2021 October, 22 (day 2) to 2021 October, 28 at 12:00 UTC. Reported frequencies are the average of 25 samples, measured with 100 s gate time.

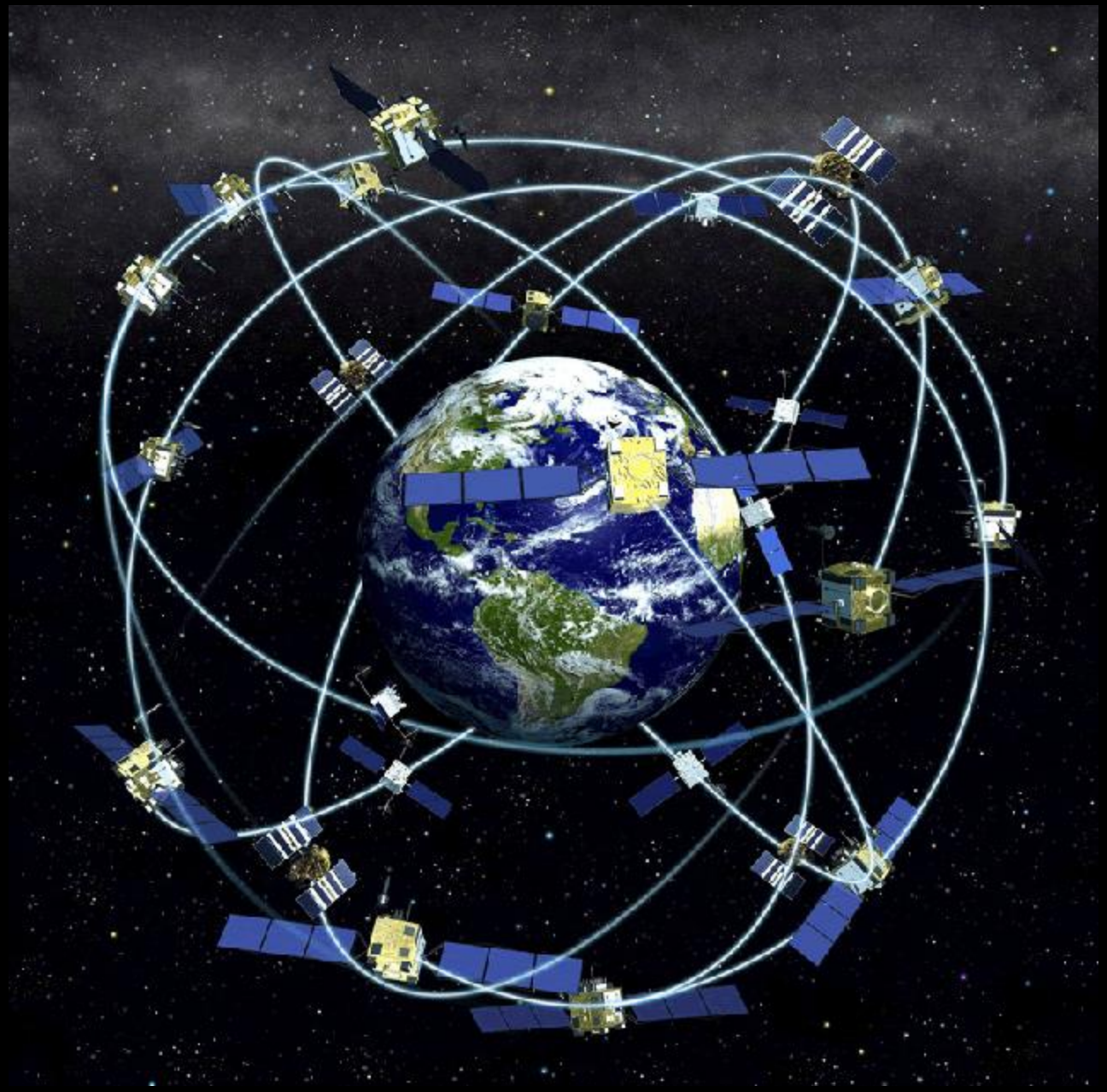
What is GPS for?

- Trying to figure out where you are is probably man's oldest pastime.

- Provides instantaneous position, velocity and time information.

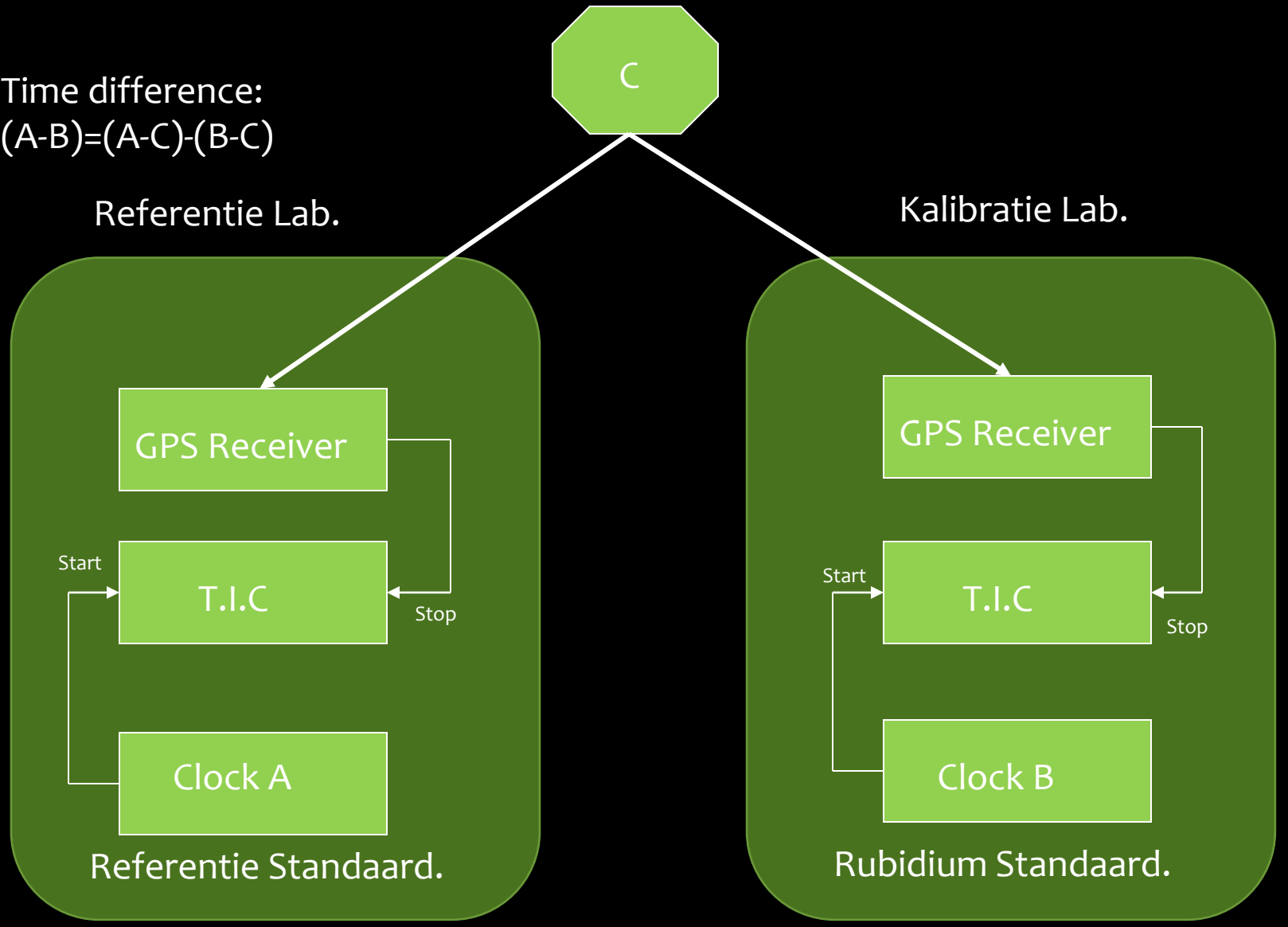
GPS Systeem

GPS Timing Receiver

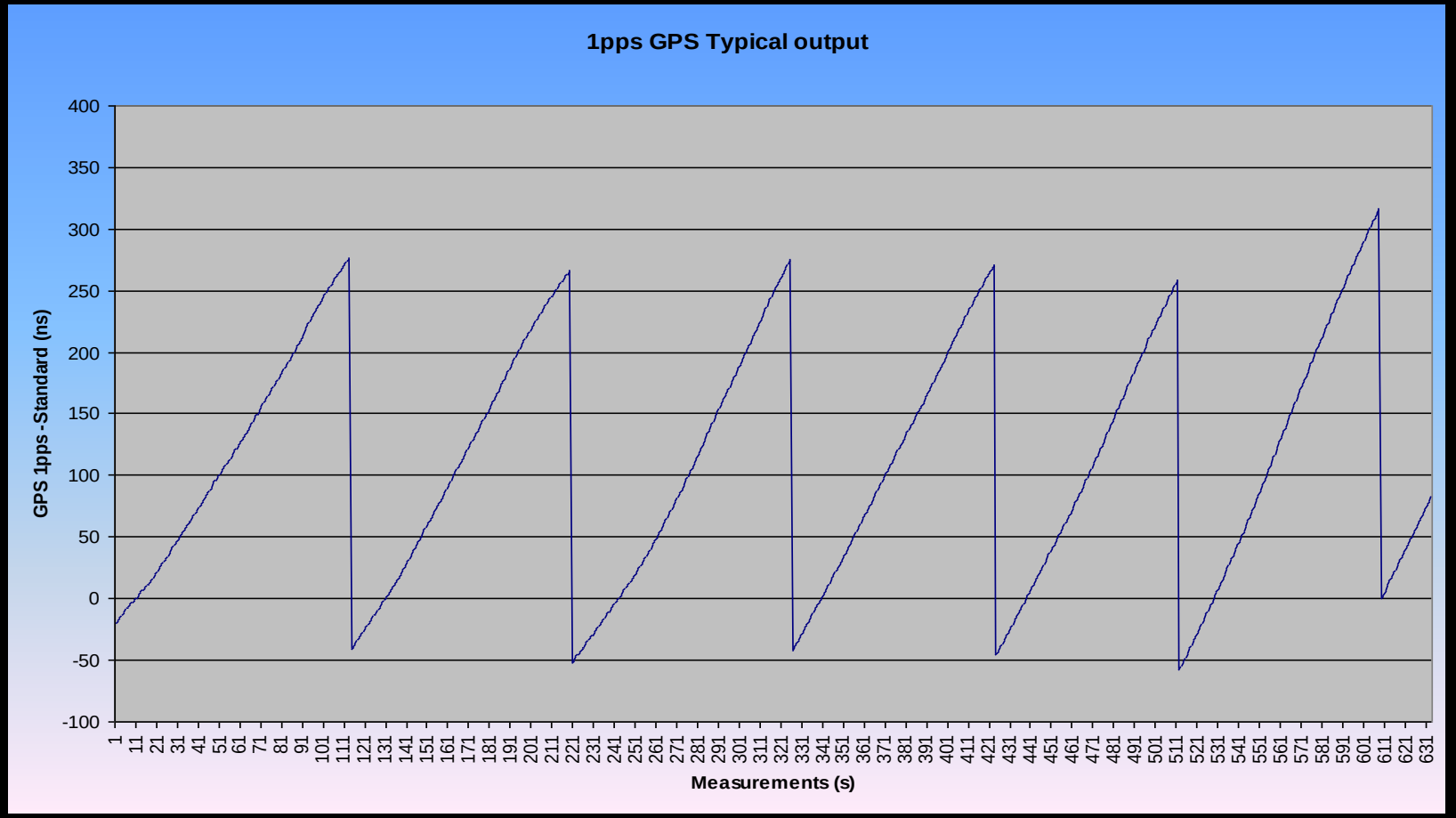


Common-View

Time difference:
(A-B)=(A-C)-(B-C)



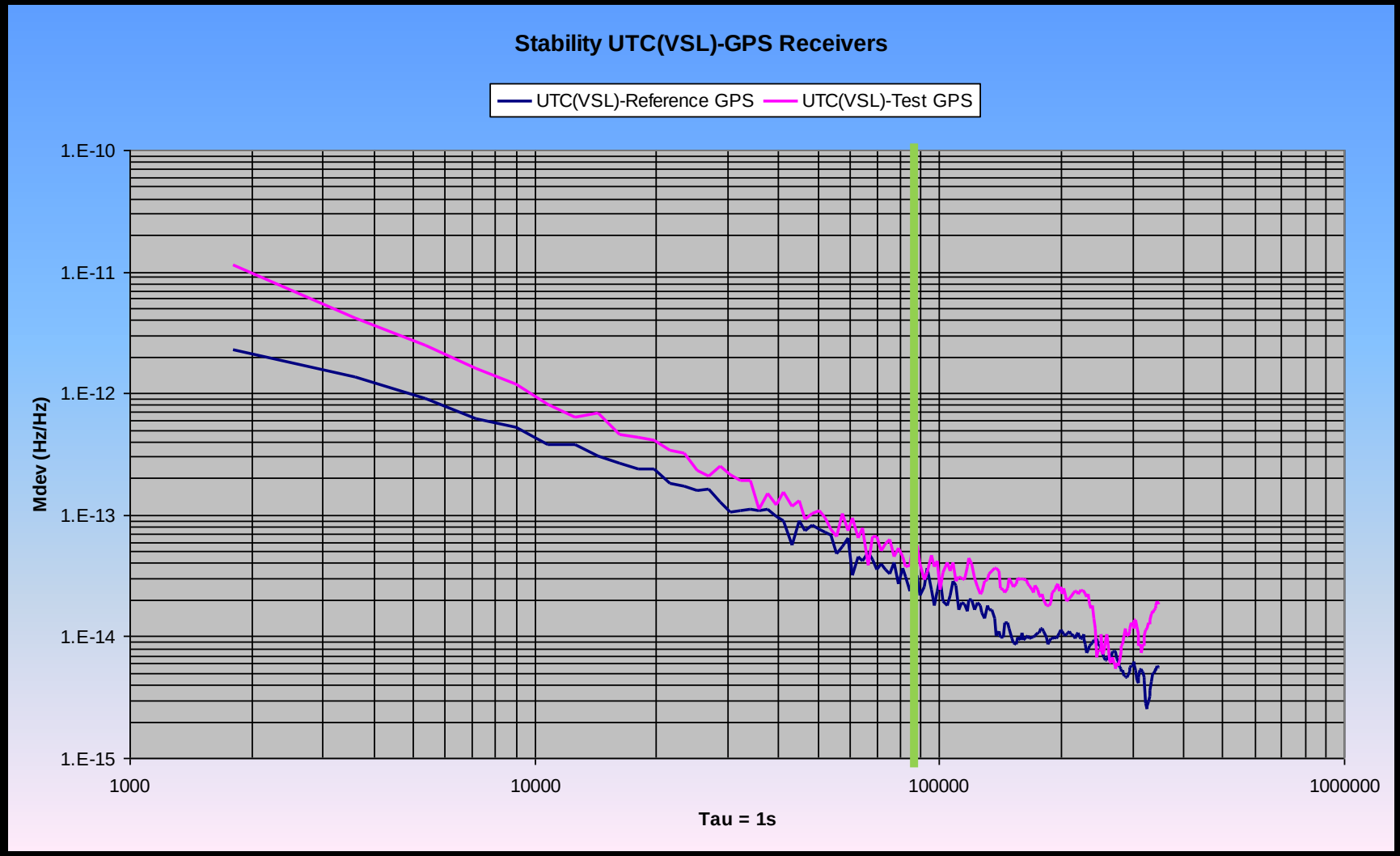
Typical 1PPS Output GPS



Quantization Error: Error due to Oscillator

Limitation of clock-cycle and pps report gives short term “noise”

Transfer Stability GPS



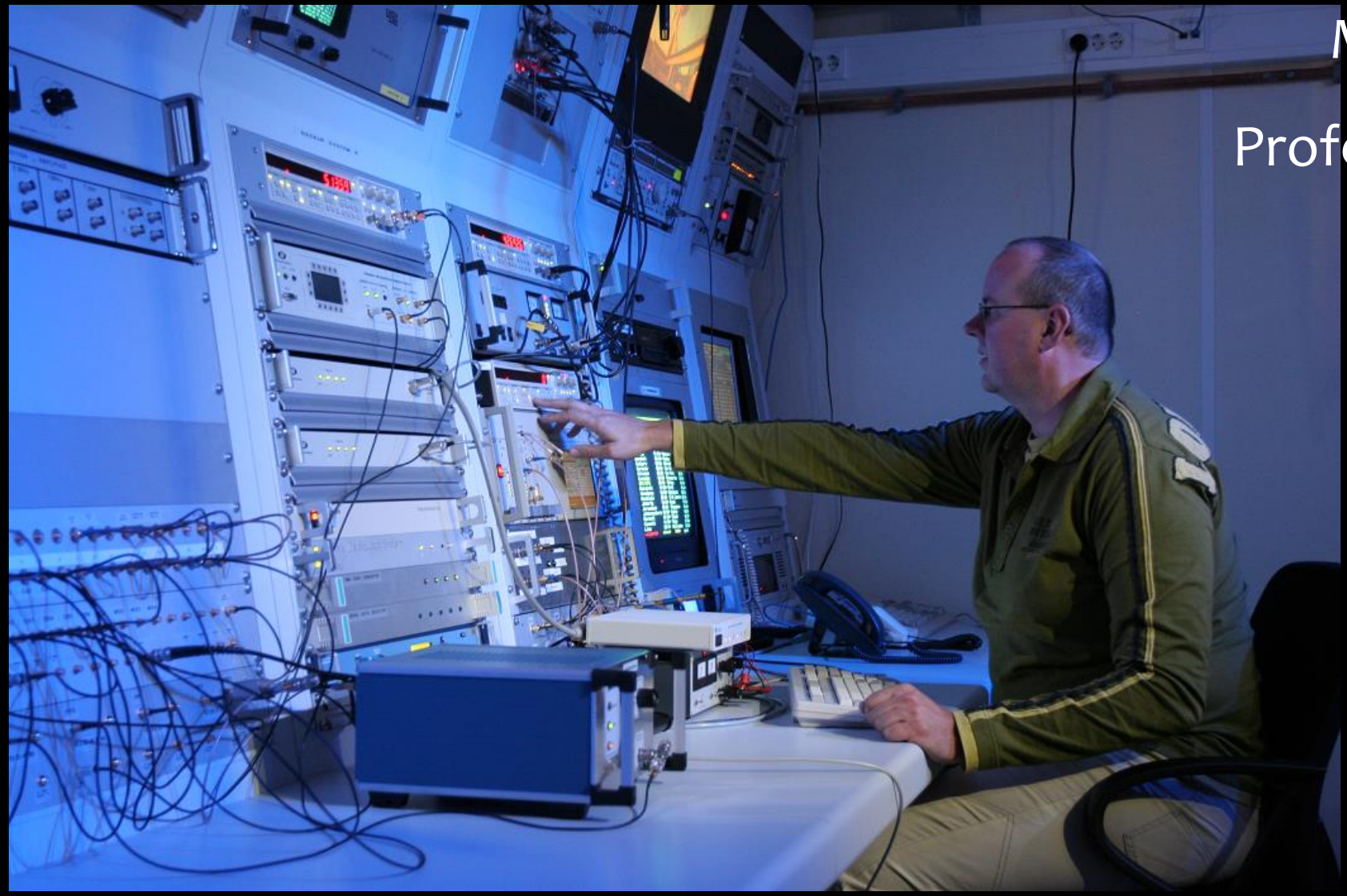
Stability Transfer $4 \cdot 10^{-13}$ Hz/Hz op 24 uur.

Referentie Laboratorium

Van Swinden Laboratorium (VSL)

Cesium Atoom Klokken

Referentie Laboratorium



Metroloog aan het werk

Professioneel Klokken kijker

Referentie Laboratorium

HP 5071A High-performance cesium beam tube

Accuracy and stability

Conditions—any combination of:

Temperature	0 to 50 °C
Humidity	0 to 80% (40 °C maximum)
Magnetic Field	dc, 55, 60 Hz; 0 to 0.2 millitesla (2 Gauss) peak—any orientation
Pressure	47 kPa (equivalent to an altitude of 6 km)
Shock and Vibration	100-mm drop

Parameter	Standard cesium beam tube. Values are within:	High-performance cesium beam tube (Option 001)
Accuracy[2]	$\pm 1 \times 10^{-12}$	$\pm 5 \times 10^{-13}$
Frequency Change vs. Environment	$\pm 1 \times 10^{-13}$	$\pm 8 \times 10^{-14}$
Warm-up Time:		

Referentie Laboratorium

Volgens de SI eenheden stelsel:

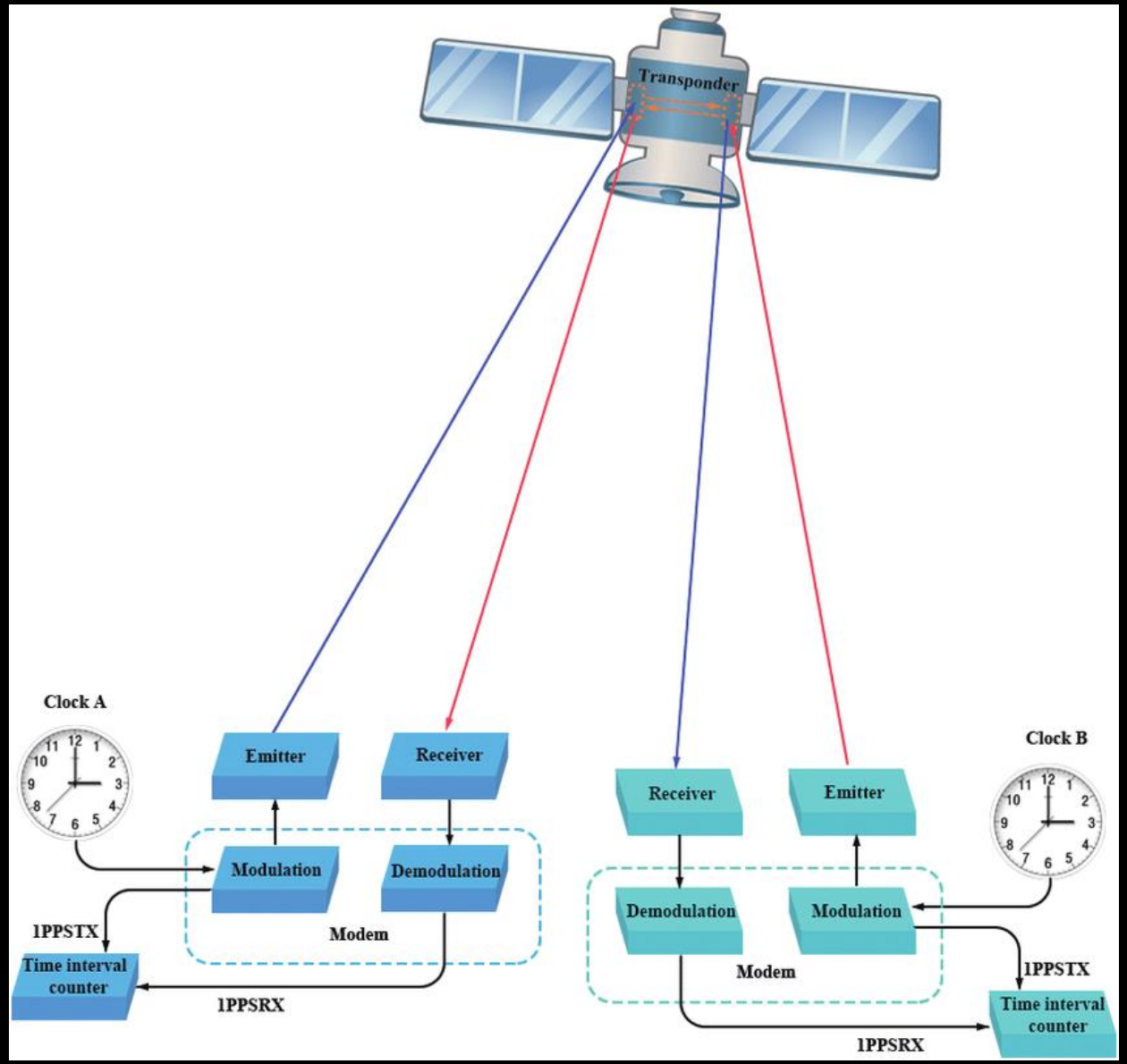
De seconde wordt gedefinieerd door de vaste numerieke waarde van de cesiumfrequentie ΔCs, de onverstoorde grondtoestand hyperfijne overgangsfrequentie van het cesium 133-atoom, te nemen op 9192631 770 uitgedrukt in de eenheid Hz, die gelijk is aan s –1

Maar hoe goed is dan de cesium atoom klok?

Vergelijking Referentie Laboratoriums

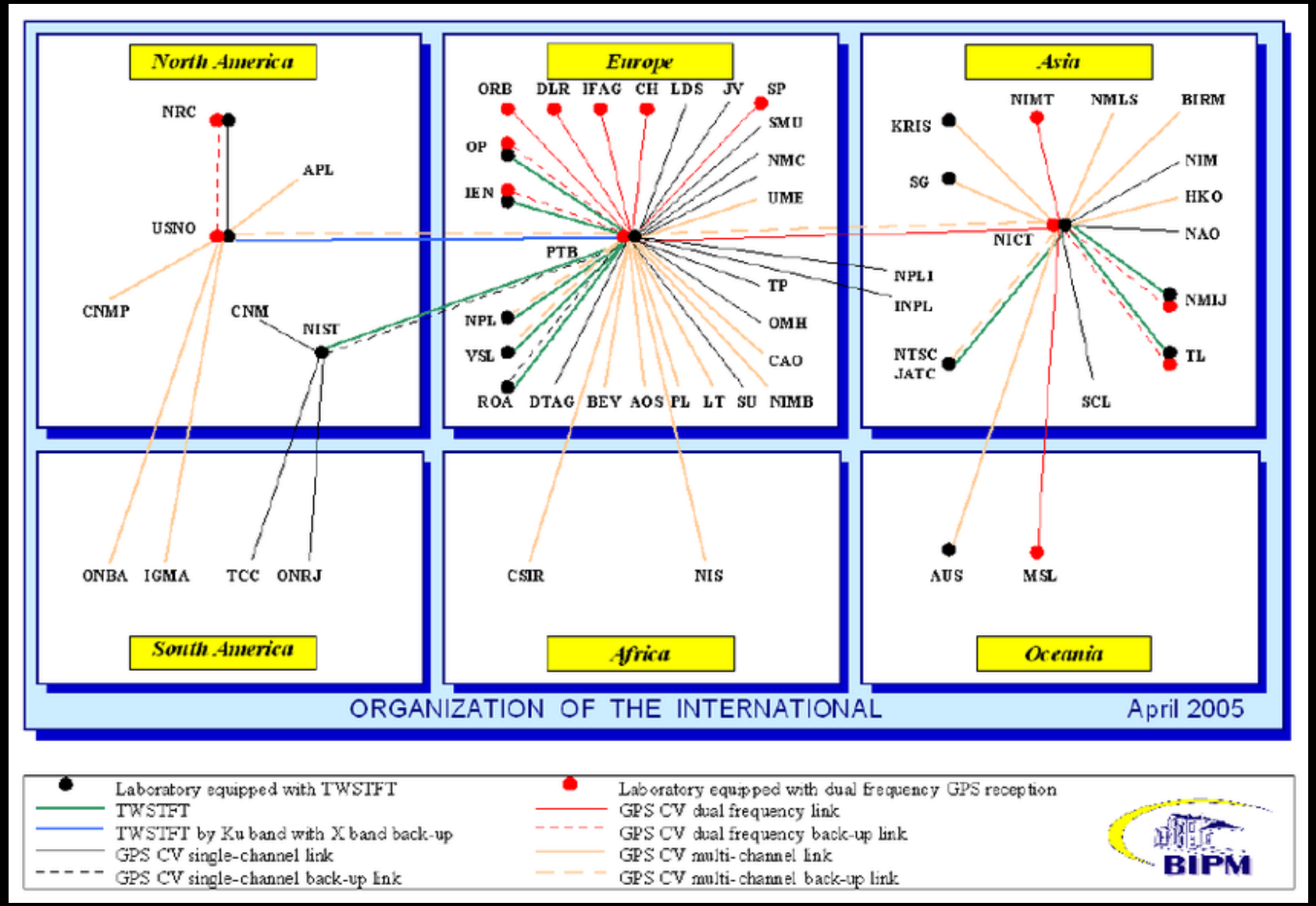
Tweerichtingssatelliettijd- en frequentieoverdracht is een zeer nauwkeurig mechanisme voor tijd- en frequentieoverdracht over lange afstanden dat wordt gebruikt tussen tijdbureaus om tijd- en frequentiestandaarden te bepalen

Satellite Time Transfer and Ranging Equipment

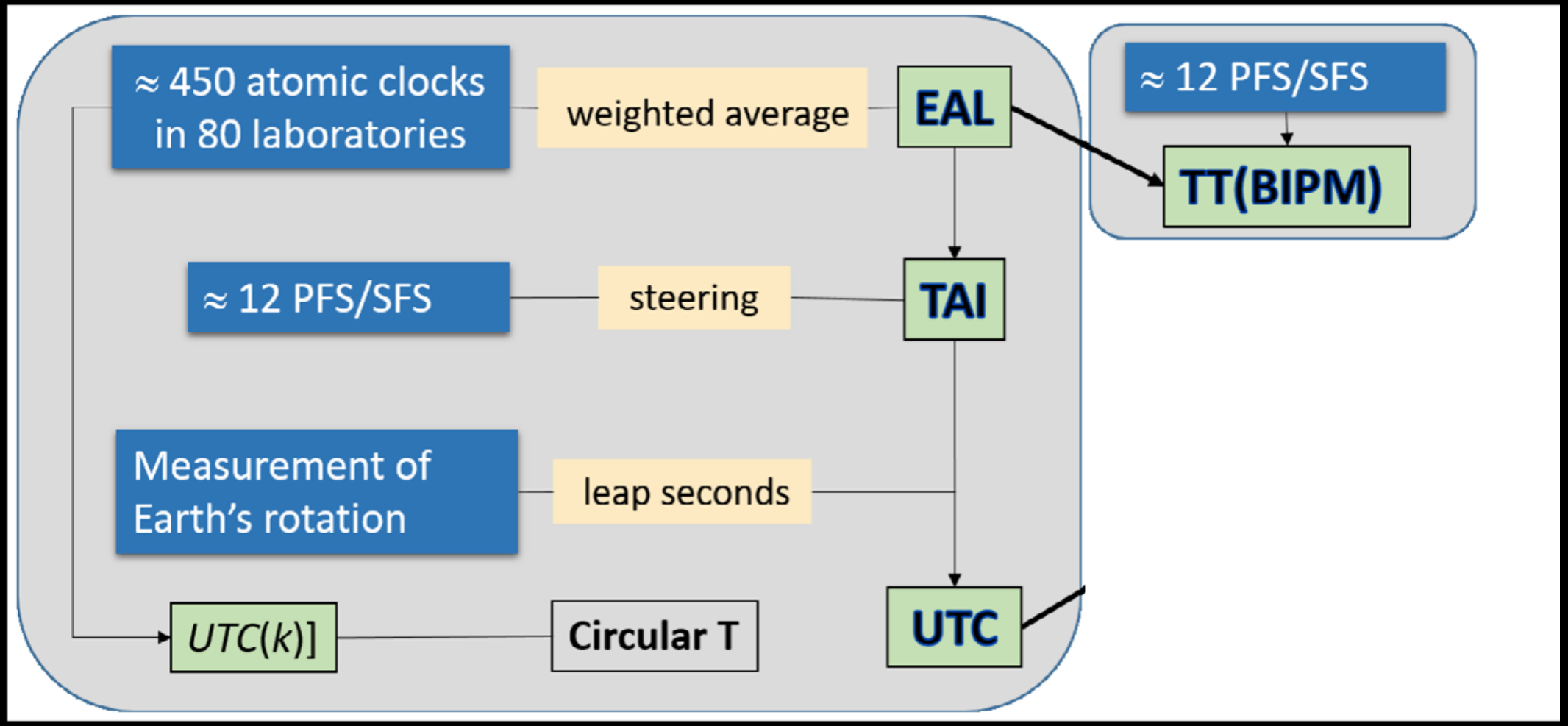


Ku Band Dubbele offset 2.8 meter schotel

Network of international time links for TAI



Representation of EAL, TAI, UTC



CIRCULAR T 409 ISSN 1143-1393

CIRCULAR T 409 ISSN 1143-1393
2022 FEBRUARY 10, 15h UTC

BUREAU INTERNATIONAL DES POIDS ET MESURES
THE INTERGOVERNMENTAL ORGANIZATION ESTABLISHED BY THE METRE CONVENTION
PAVILLON DE BRETEUIL F-92312 SEVRES CEDEX TEL. +33 1 45 07 70 70 tai@bipm.org

The contents of the sections of BIPM Circular T are fully described in the document "Explanatory supplement to BIPM Circular T" available at https://webtai.bipm.org/ftp/pub/tai/other-products/notes/explanatory_supplement_v0.6.pdf

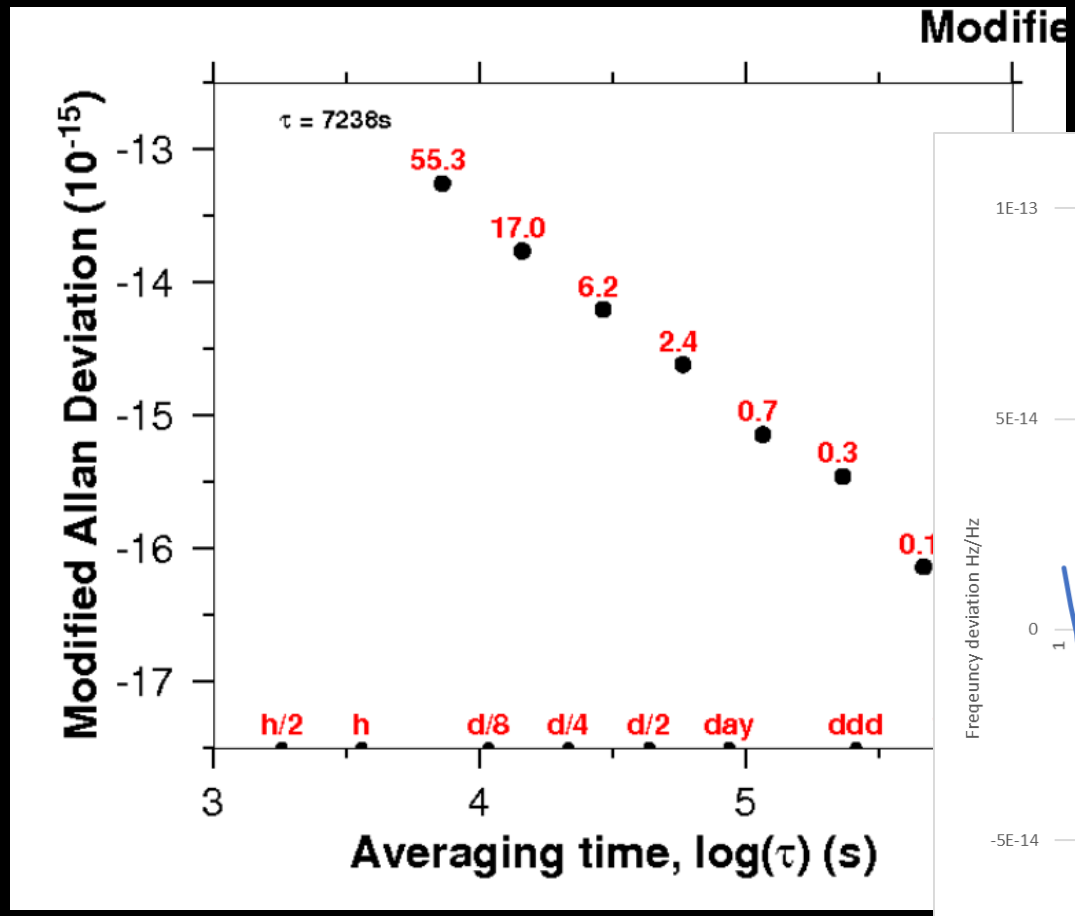
1 - Difference between UTC and its local realizations UTC(k) and corresponding uncertainties.
From 2017 January 1, 0h UTC, TAI-UTC = 37 s.

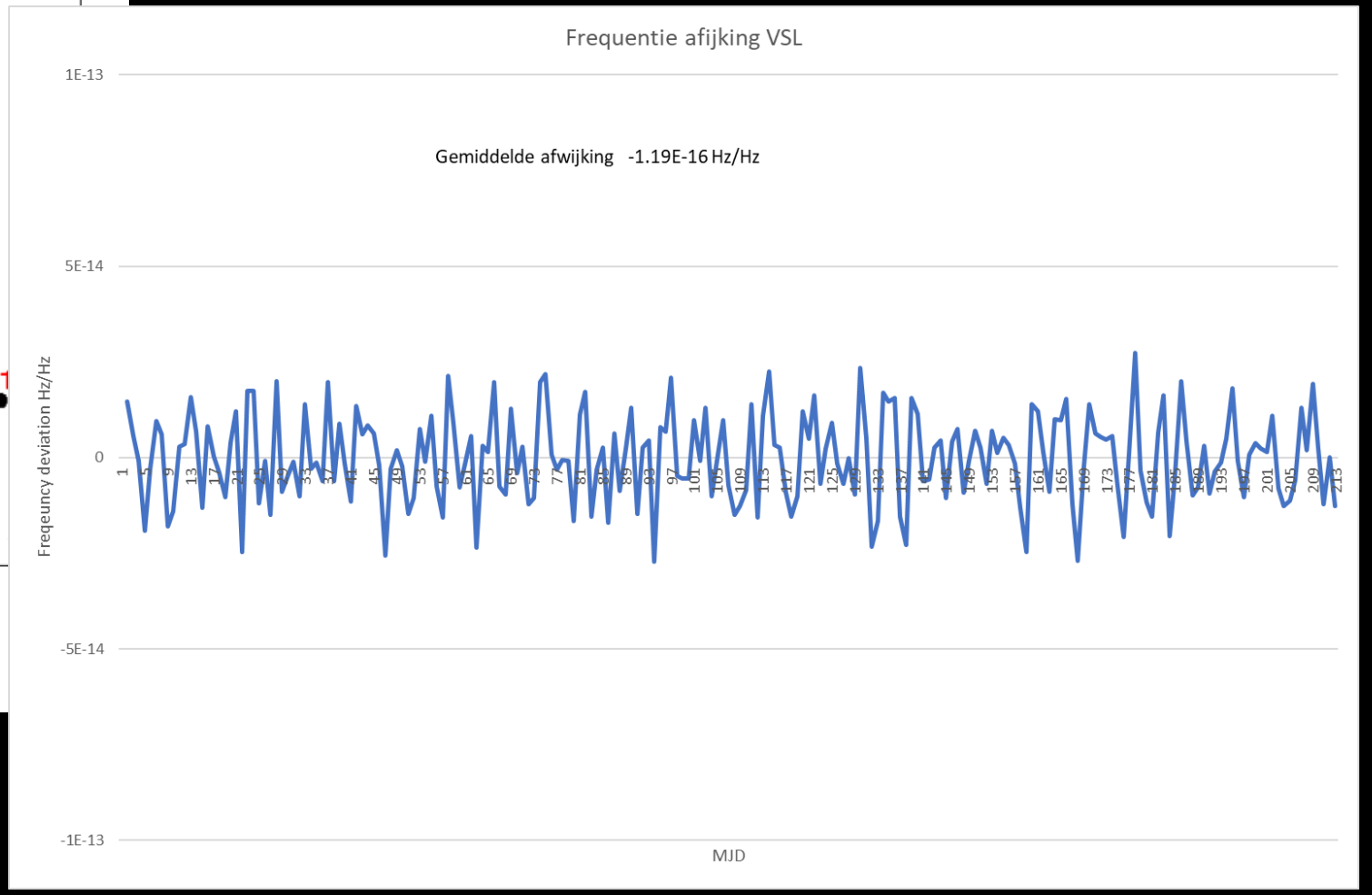
Date 2021/22 0h UTC	DEC 31	JAN 5	JAN 10	JAN 15	JAN 20	JAN 25	JAN 30	Uncertainty/ns		Notes
MJD	59579	59584	59589	59594	59599	59604	59609	uA	uB	u
Laboratory k	[UTC-UTC(k)]/ns									
VSL (Delft)	-6.2	-5.4	2.9	3.9	-1.4	-1.4	-6.9	0.3	1.5	1.5

5 - Time links used for the computation of TAI, calibrations information and corresponding uncertainties.

Link	Type	Equipment	Cal_ID	uStb/ns	uCal/ns	uAg/ns	Al/ns	YYMM
VSL /PTB	TWGPPP	VSL01 /PTB05	0527-2021	0.3	1.3	0.6		

VSL Data


Modifie
τ = 7236s
55.3
17.0
6.2
2.4
0.7
0.3
0.1
h/2
h
d/8
d/4
d/2
day
ddd
Modified Allan Deviation (10^-15)
-13
-14
-15
-16
-17
3
4
5
Averaging time, log(τ) (s)


Frequentie afijking VSL
Gemiddelde afwijking -1.19E-16 Hz/Hz
1E-13
5E-14
0
-5E-14
-1E-13
Freqeuncy deviation Hz/Hz
MJD

En zo doe je dat dus!