Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
National Metrology Institute

UTC(PTB) as the basis for legal time in Germany: realization and dissemination

8th International Symposium “Metrology of Time and Space“
St. Petersburg, 14 - 16 September 2016,
Plenary Session

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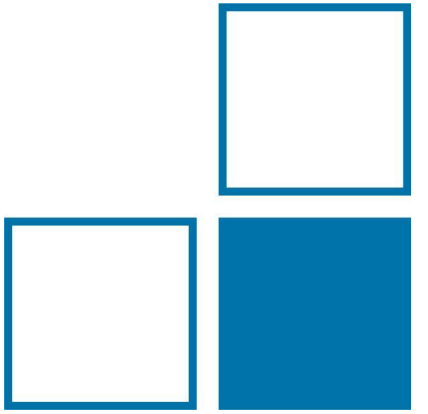
Thomas Polewka, Dieter Sibold, Stefan Weyers



UTC(PTB) as the basis for legal time in Germany: realization and dissemination

- **By law, PTB is responsible for the realization and dissemination of the time unit and of legal time within Germany.**
- **UTC(PTB) is the basis of all activities in this regard.**
- **Dissemination is accomplished via radio transmitter DCF77, NTP and telephone.**

- **The realization of UTC(PTB) has to be reliable, redundant, and easy to be operated.**
- **UTC(PTB) shall be predictable and the scale unit shall comply with the SI second (with small deviations).**

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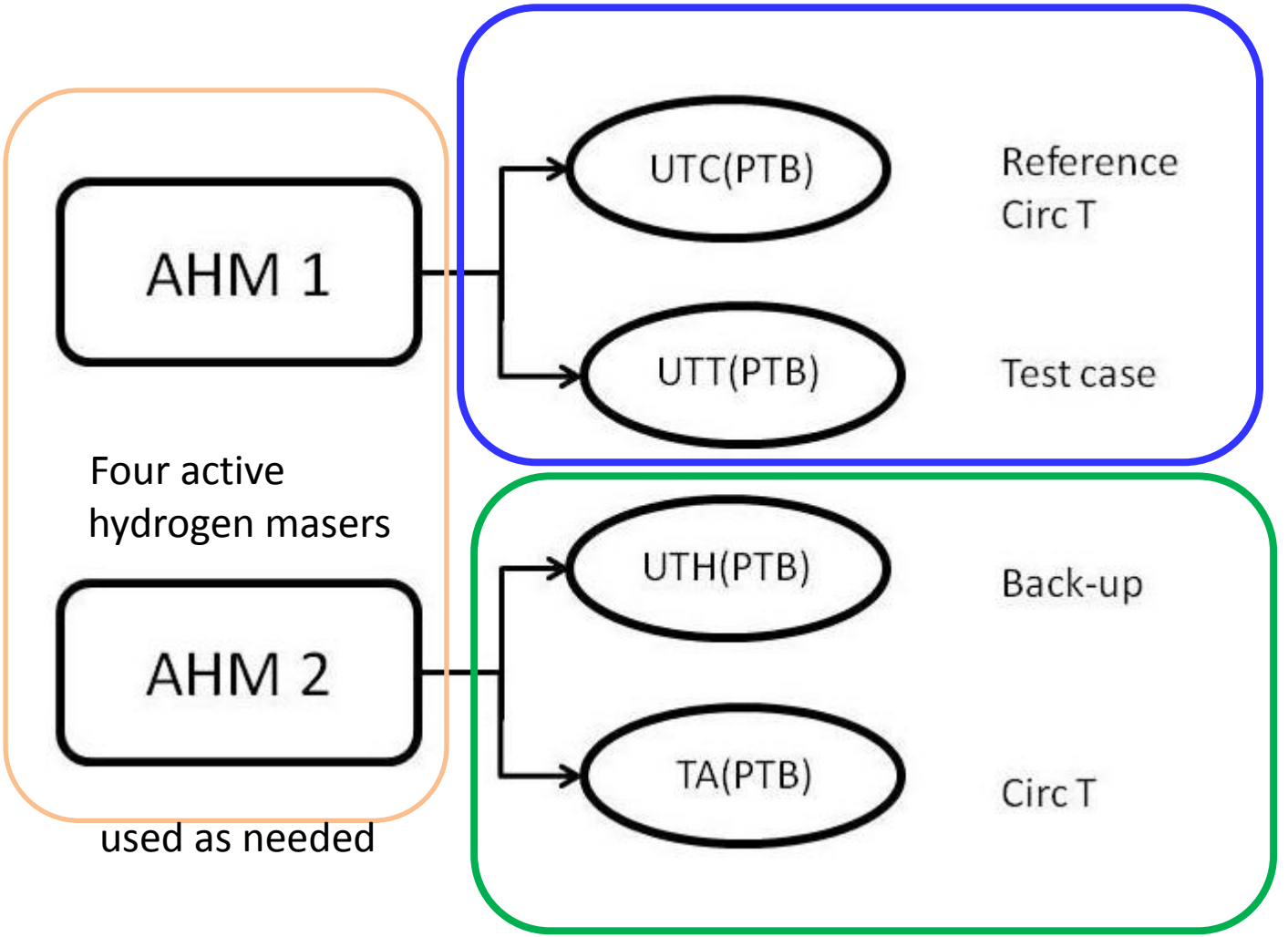
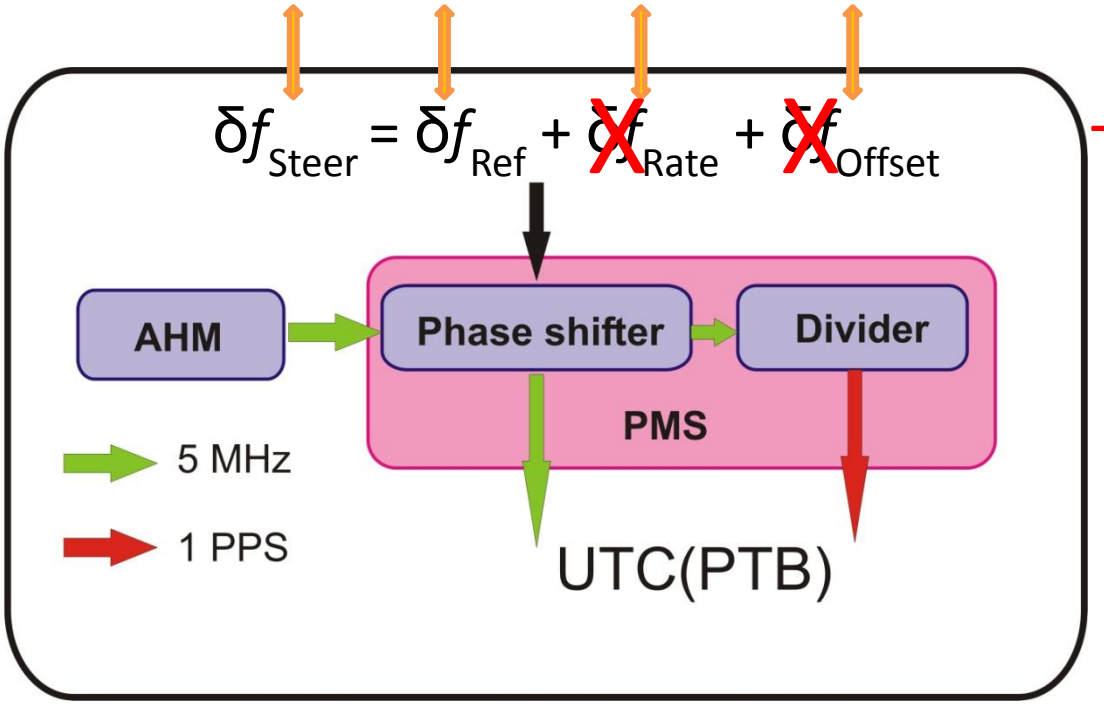


Realization of UTC(PTB) 2010 - 2016

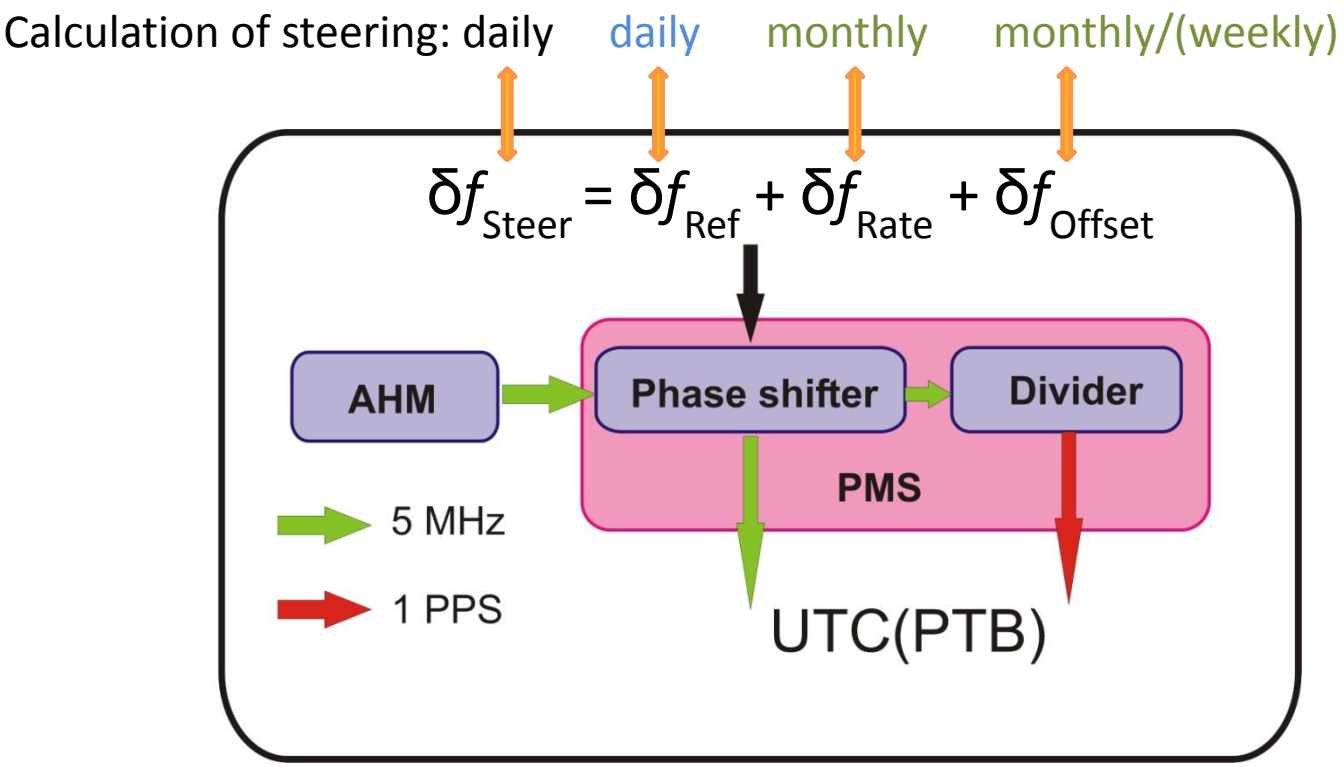
internal external sources

Calculation of steering: daily daily monthly monthly/(weekly)



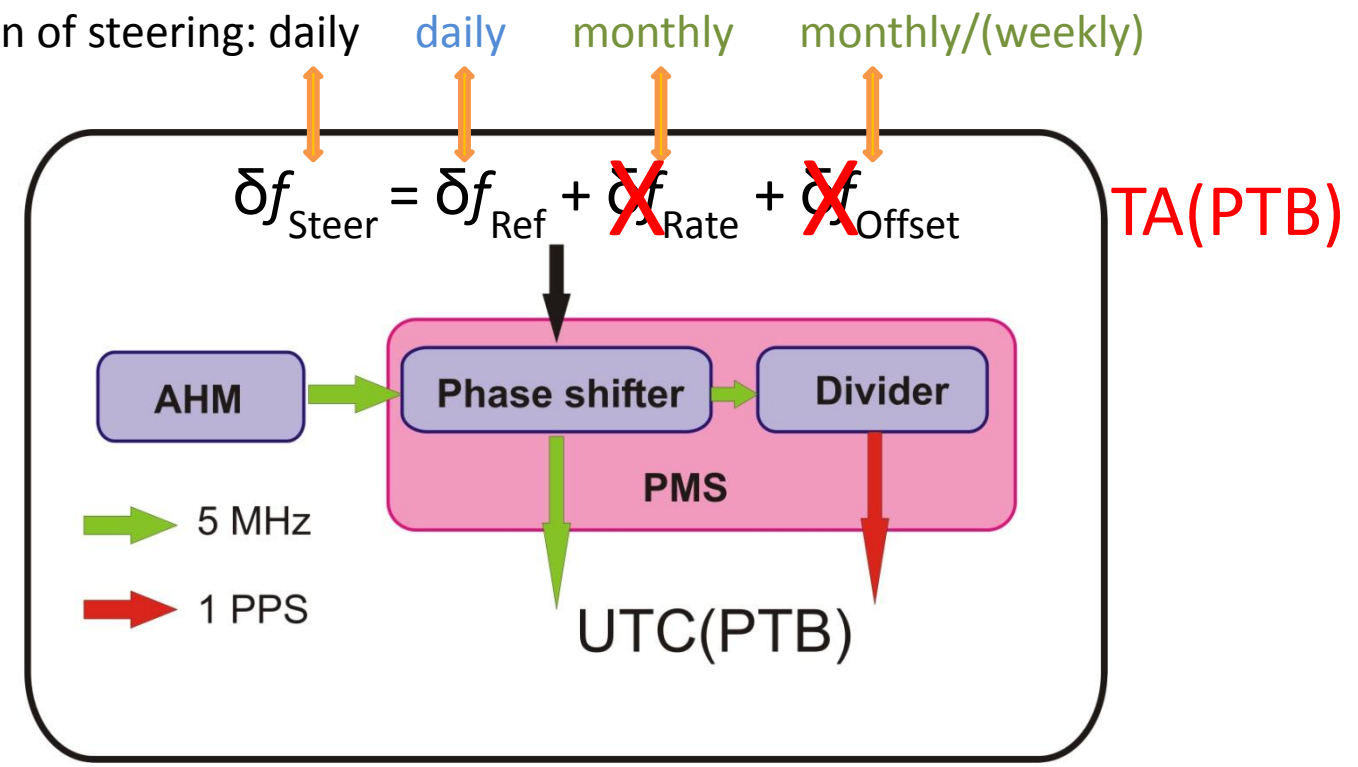
Literature on details:

Bauch et al., Generation of UTC(PTB) as a fountain-clock based time scale , Metrologia **49** (2012) 180–188
Bauch et al., A Status Report on Time Scale Generation in PTB, Proc. 2015 IFCS/EFTF 379 – 384.
Rovera et al., UTC(OP) based on LNE-SYRTE atomic fountain PFS, Metrologia **53** (2016) S81–S88



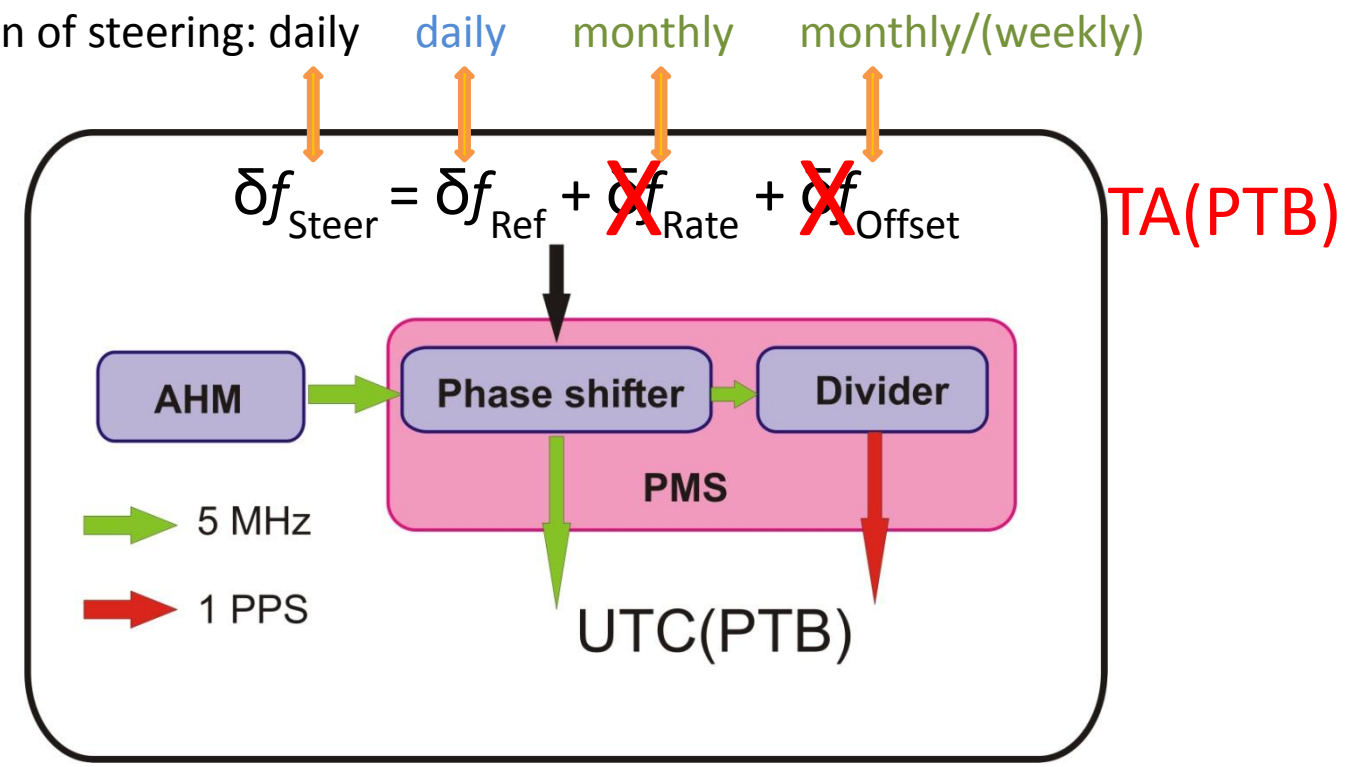
δf_{Ref}: represents frequency offset between AHM and steering references
Which averaging time?
depends on instability of the maser and the steering references,
on the reliability of data delivery

Calculation of steering: daily



δf_{Rate} : represents rate offset between steering references and TAI
Available monthly
PTB: use TAI scale interval d from CircularT, Section 3, apply during next month
OP: mean rate of UTC(OP) – UTC, predict for the next month

Calculation of steering: daily



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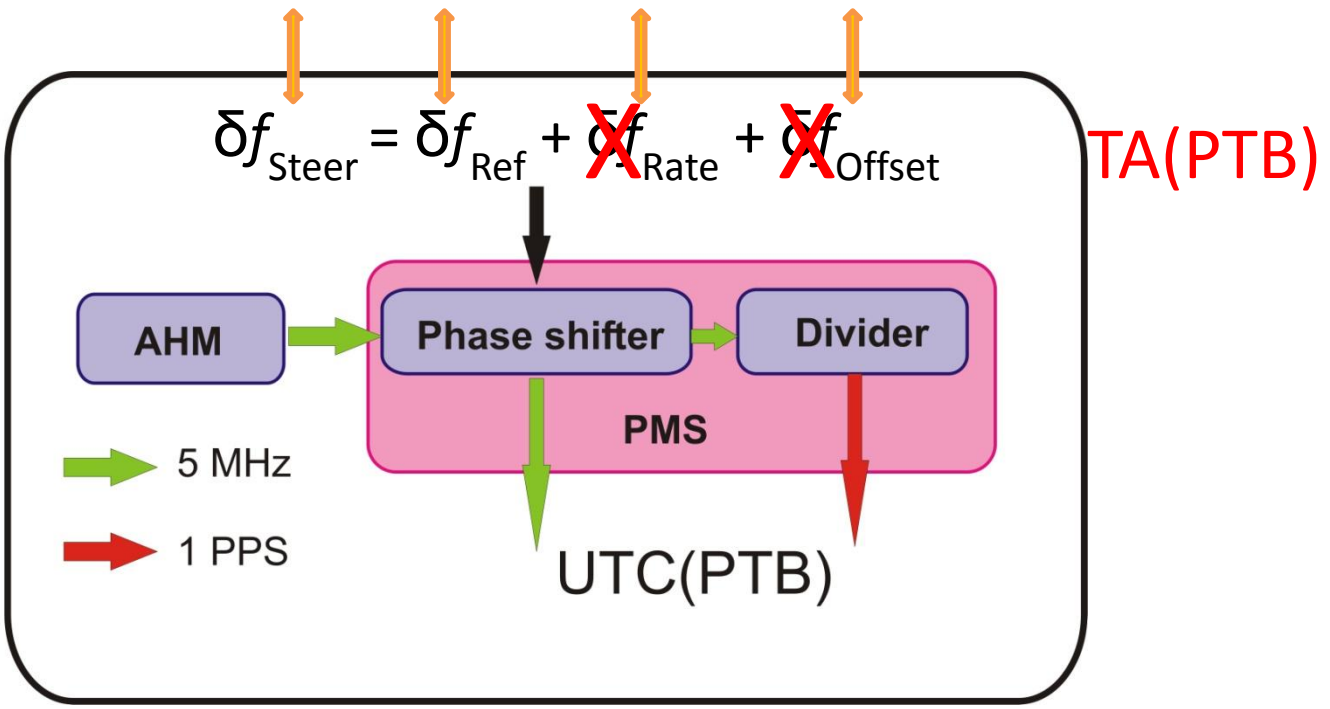
δf_{Offset} : suppression of time difference UTC-UTC(k) at the end of the month
available monthly

Calculation of steering: daily daily monthly monthly/(weekly)



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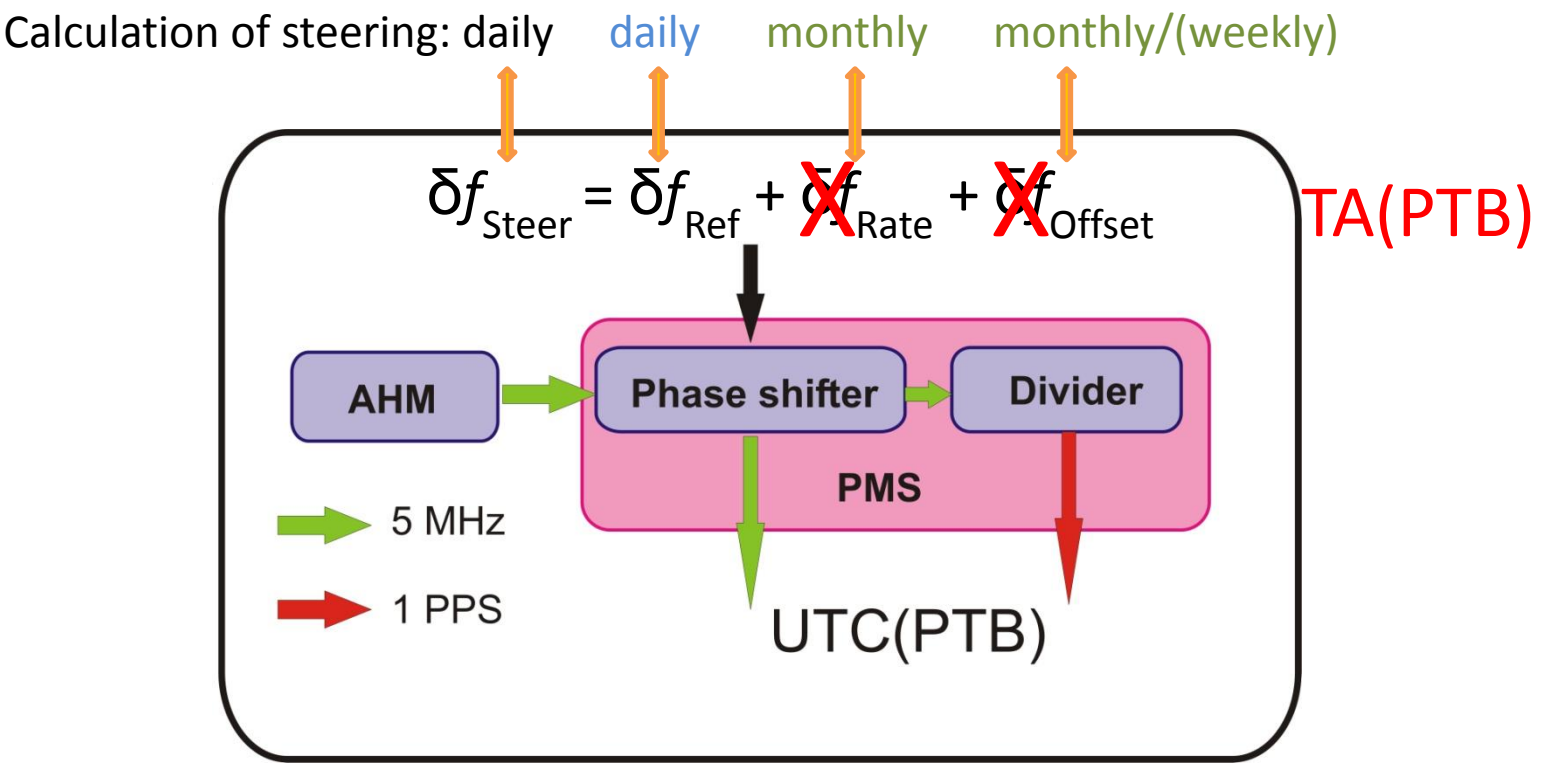
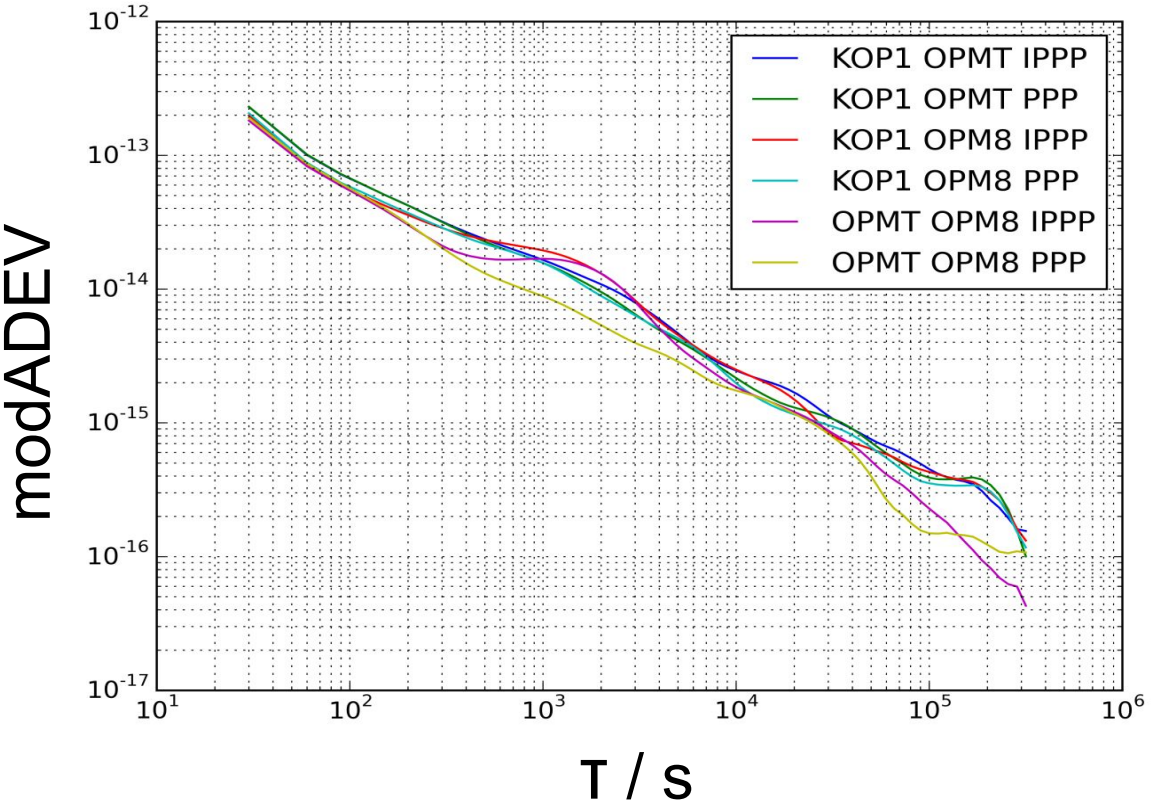
PTB: Calculation of δf_{Steer} five times in parallel, depending on available references:
CSF1, CSF2 , mean (CSF1+CSF2), CS2, mean(CS1, CS2, 3 x 5071)
With adapted avg. times, clock rates from rTAI, weights based on stability during three months
Selection of δf_{Steer} based on priorization



The group of AHM at PTB, photo 05.Sept. 2016

Stable masers simplify time scale generation..



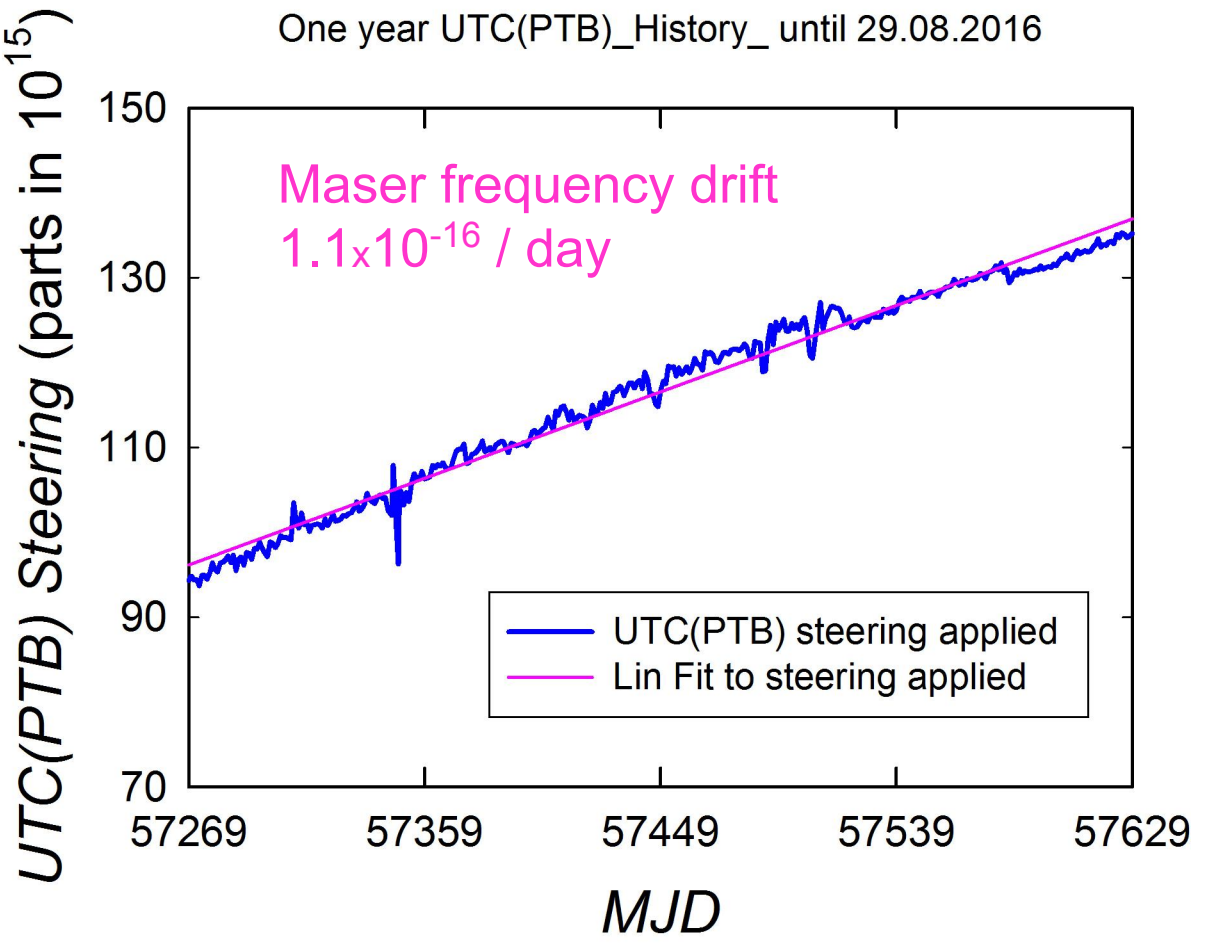
Comparison of AHM in PTB and OP using GPS, evaluated via PPP and IPPP

MJD 57183 to MJD 57197

Credit: Julia Leute
Gerard Petit,
CNES (GINS)

Literature on IPPP: **Gérard Petit, Amale Kanj, Sylvain Loyer, Jérôme Delporte, Flavien Mercier and Félix Perosanz, 1×10^{-16} frequency transfer by GPS PPP with integer ambiguity resolution, Metrologia 52 (2015) 301–309**

UTC(PTB) as the basis for legal time in Germany: realization and dissemination



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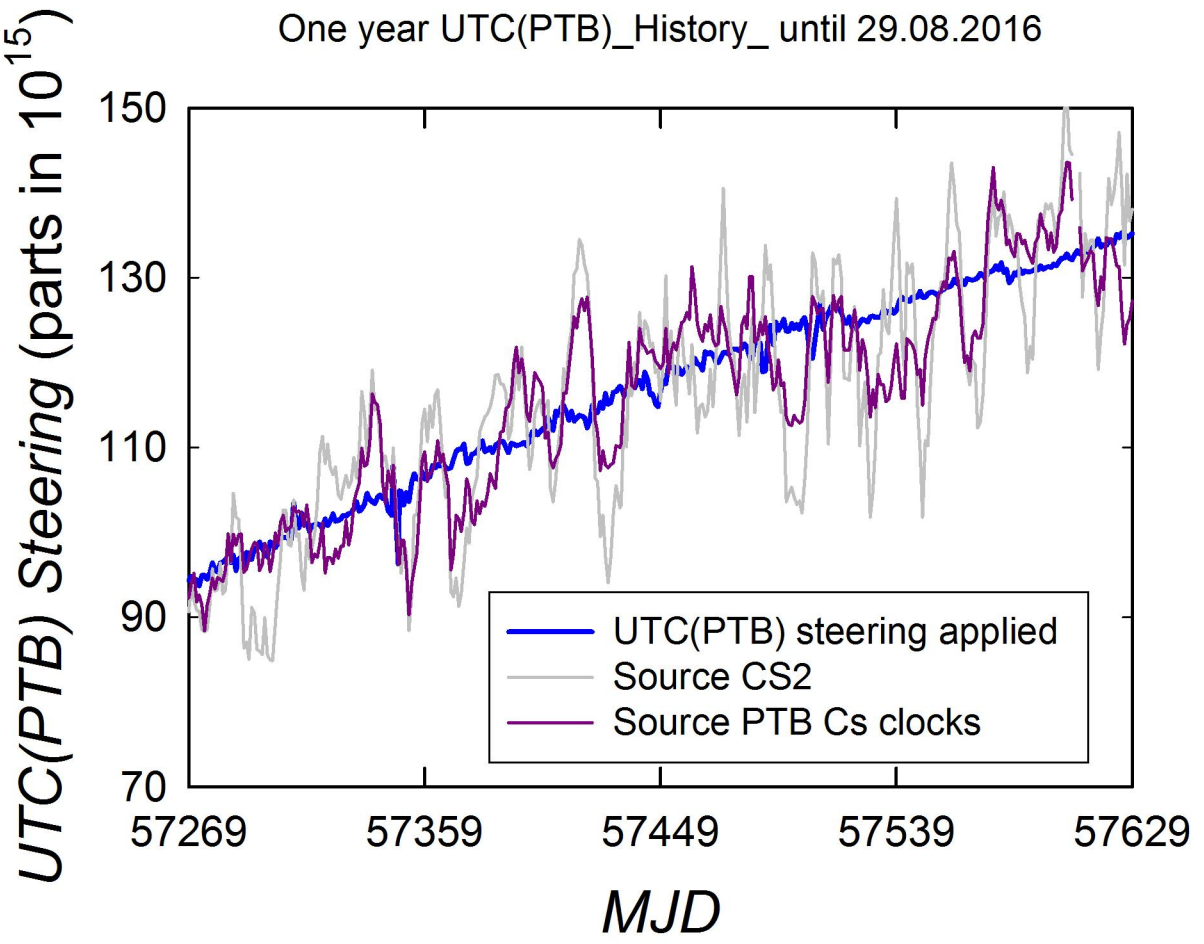

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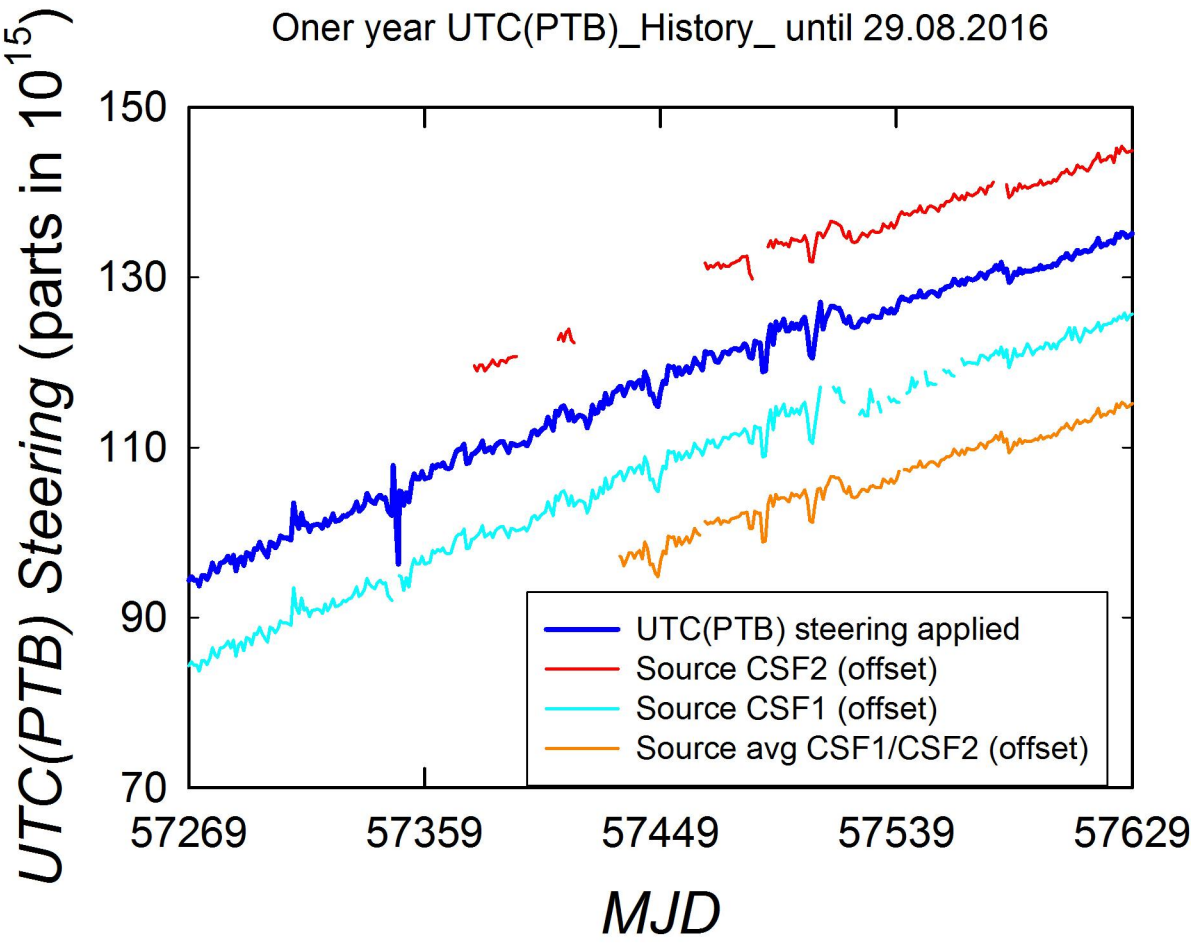

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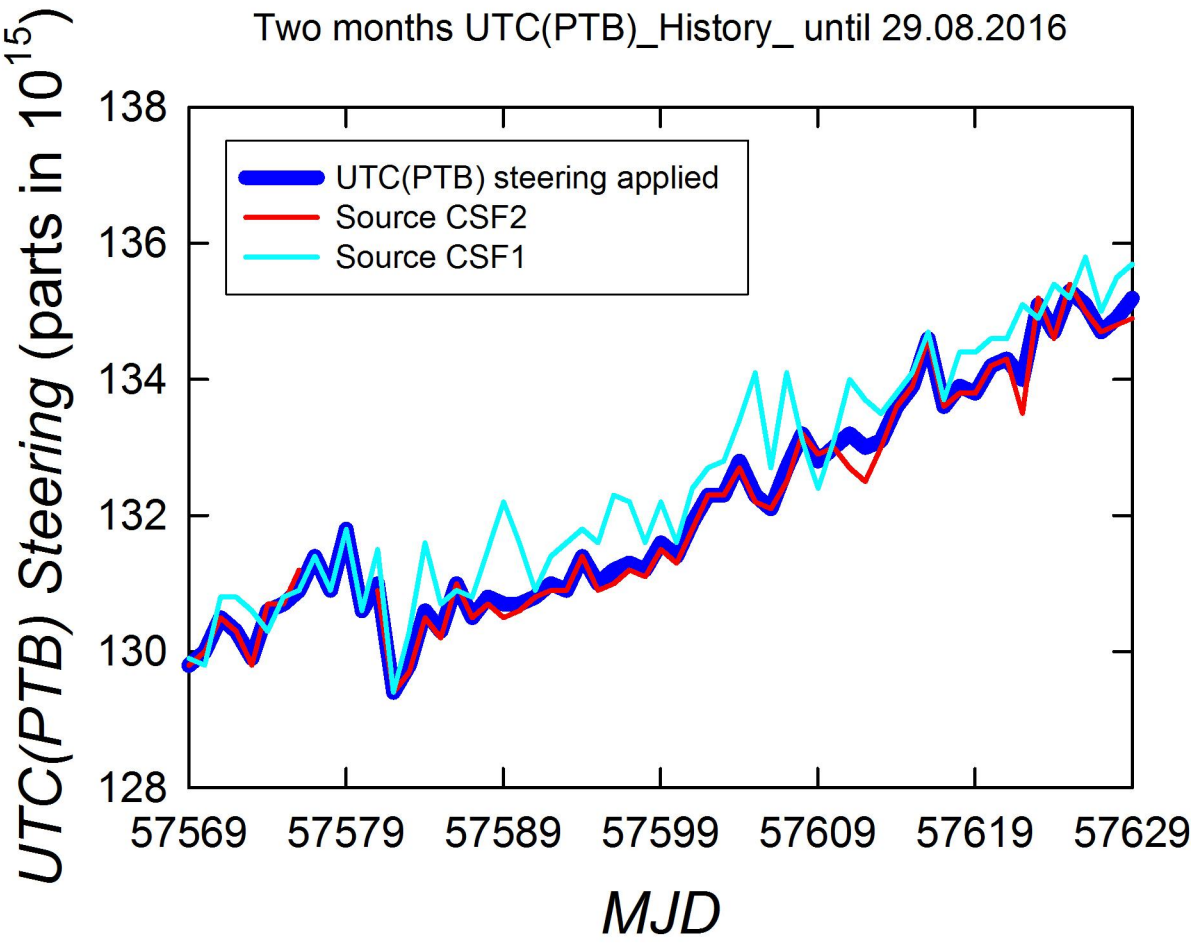

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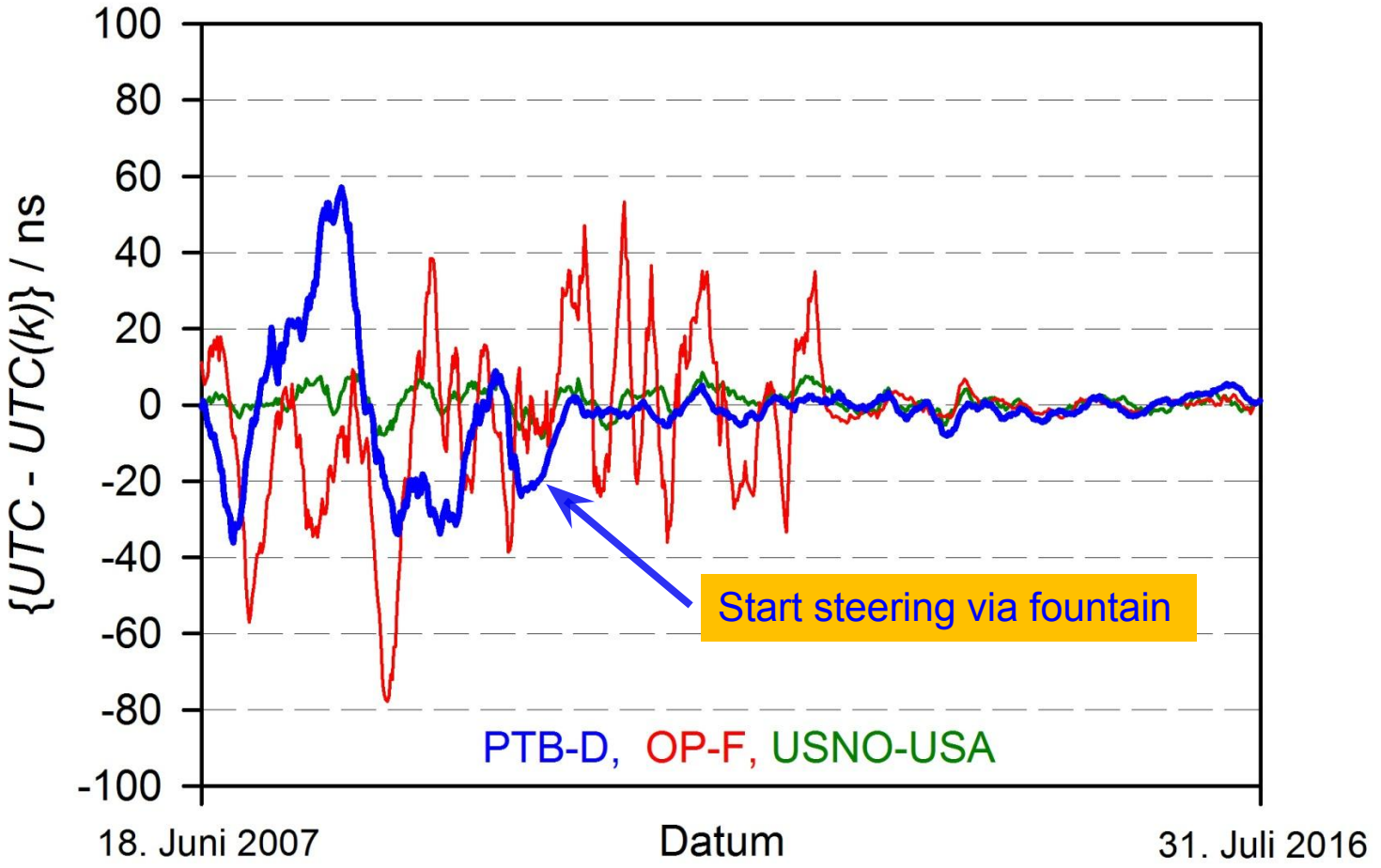
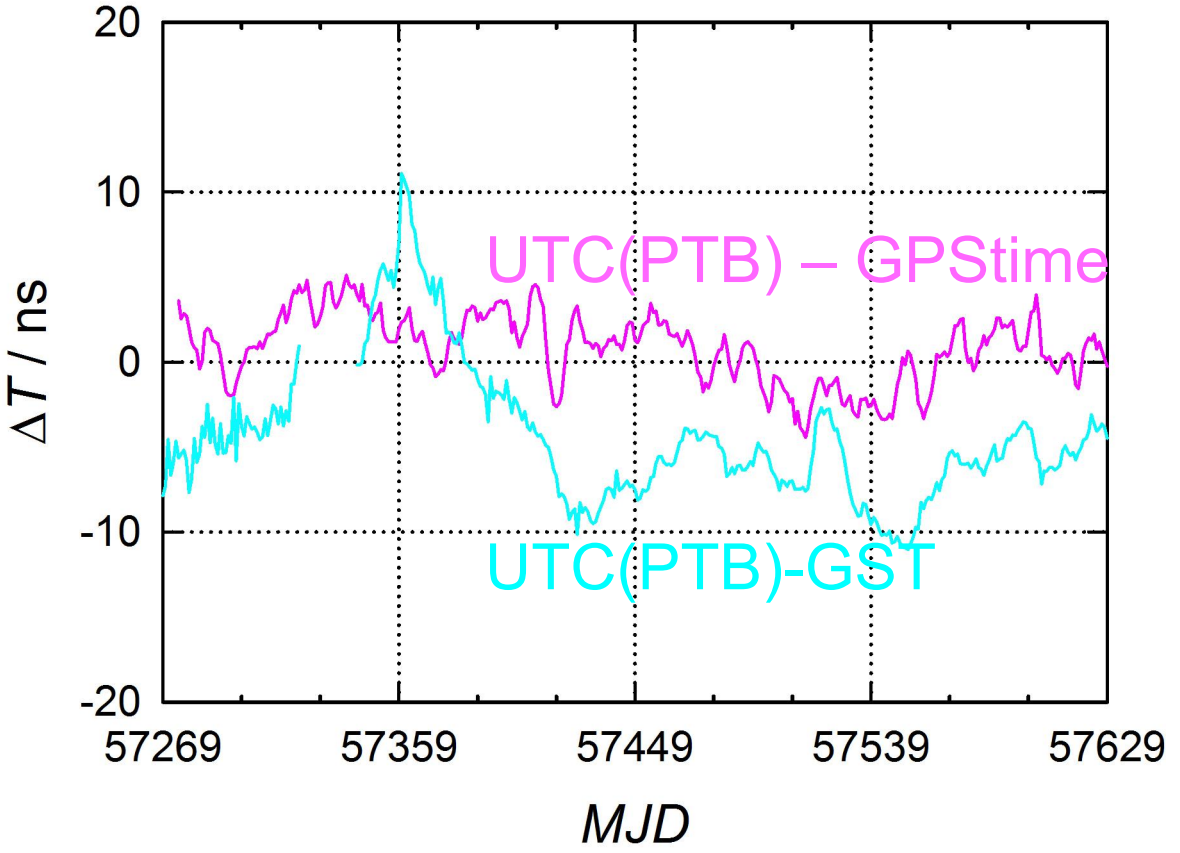
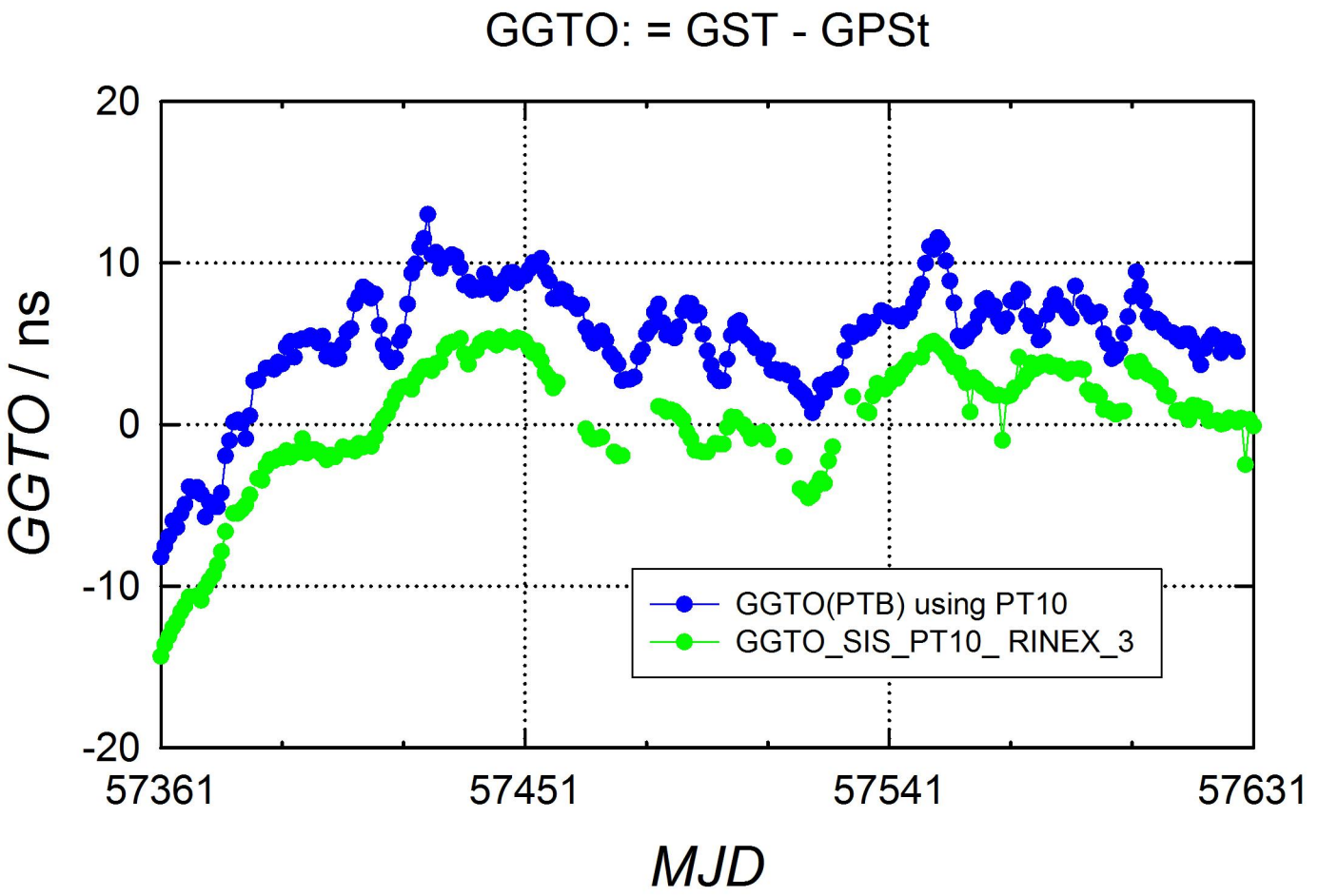


Documentation of daily mean values in PTB's Time Service Bulletin
Provision of CGGTTS and RINEX files from all PTB receivers at ftp.ptb.de/pub/time/GNSS

Recording of GNSS system times from SIS wrt to UTC(PTB)
Calibrated for GPS (P1, P2) and Galileo (E1, E5) delays



Future service:
Providing the difference between GPStime and Galileo System Time GST



List of services offered by PTB in the context of dissemination of legal time

Method	WEB	NTP	PTP	DCF77	Telephone-time service	GNSS
Roll of PTB	provider	provider	provider	provider	provider	Monitoring
usage	global	global	On campus	Europa	Germany	global
accuracy	1 s	1 ms	1 µs	50 µs	1 s	10 ns
Users / requests	?	ca. 3×10^8 per day	internal	ca. 10^8 receivers	1800 calls per day	Specialized user

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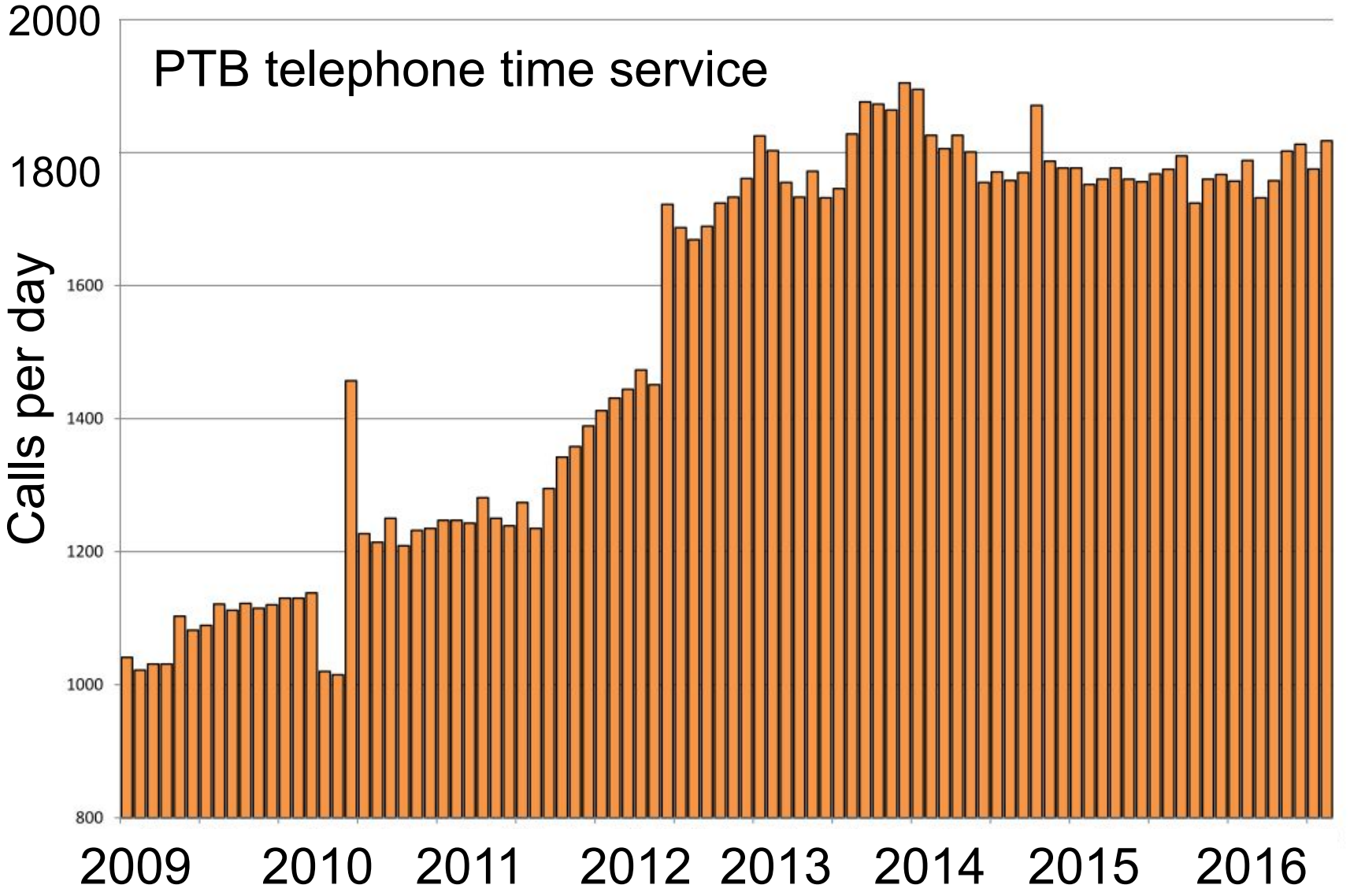
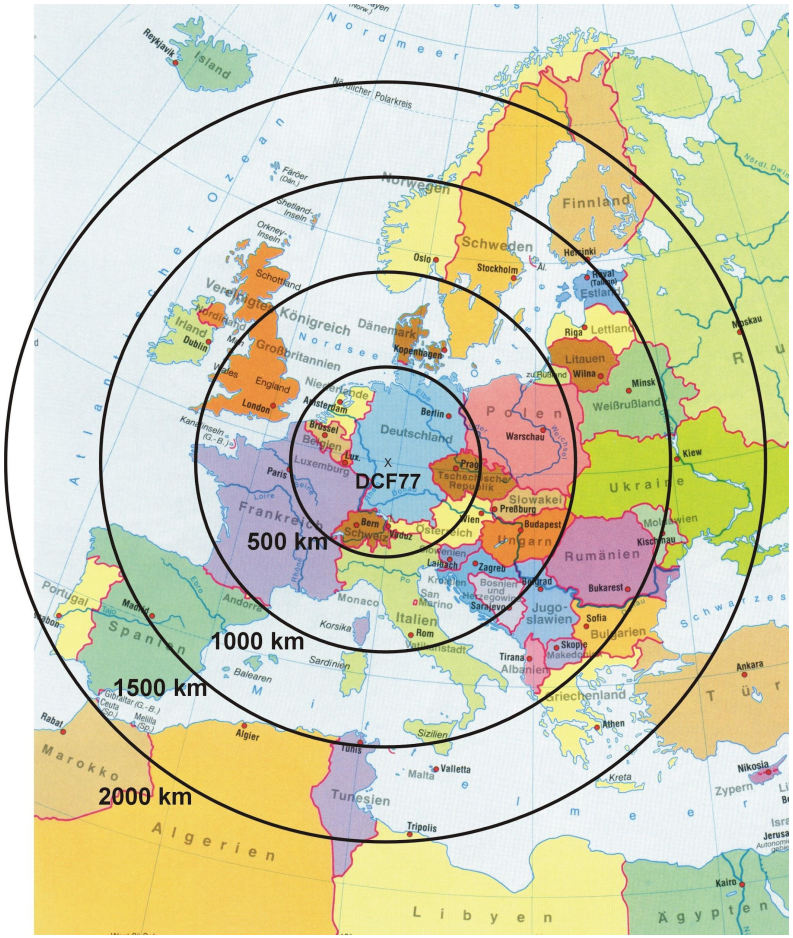


DCF77

about 10^8 receivers

Service contractually secured until 2021



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Current Activities at PTB :

- **Network Time Security (NTS) provides:**
  - Authenticity of time servers
  - Ability to authenticate time clients to the server
  - Ability to perform authorization checks for time clients and servers
  - Integrity of synchronization data packets
  - Conformity with TICTOC's Security Requirements (RFC 7384)
  - Support for NTP
  - Ability for other time synchronization protocols, e. g. PTP

for details contact Dieter Sibold

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httpps://uhr.ptb.de

The End

Time keeping is a team business:

Fountains at PTB:
Stefan Weyers, Vladi Gerginov, Michael Kazda

Operation of PTB clocks, daily supervision of equipment and software operations:
Christof Richter, Egle Staliuniene