



The New Results of GNSS System Time Differences (Offsets) Monitoring

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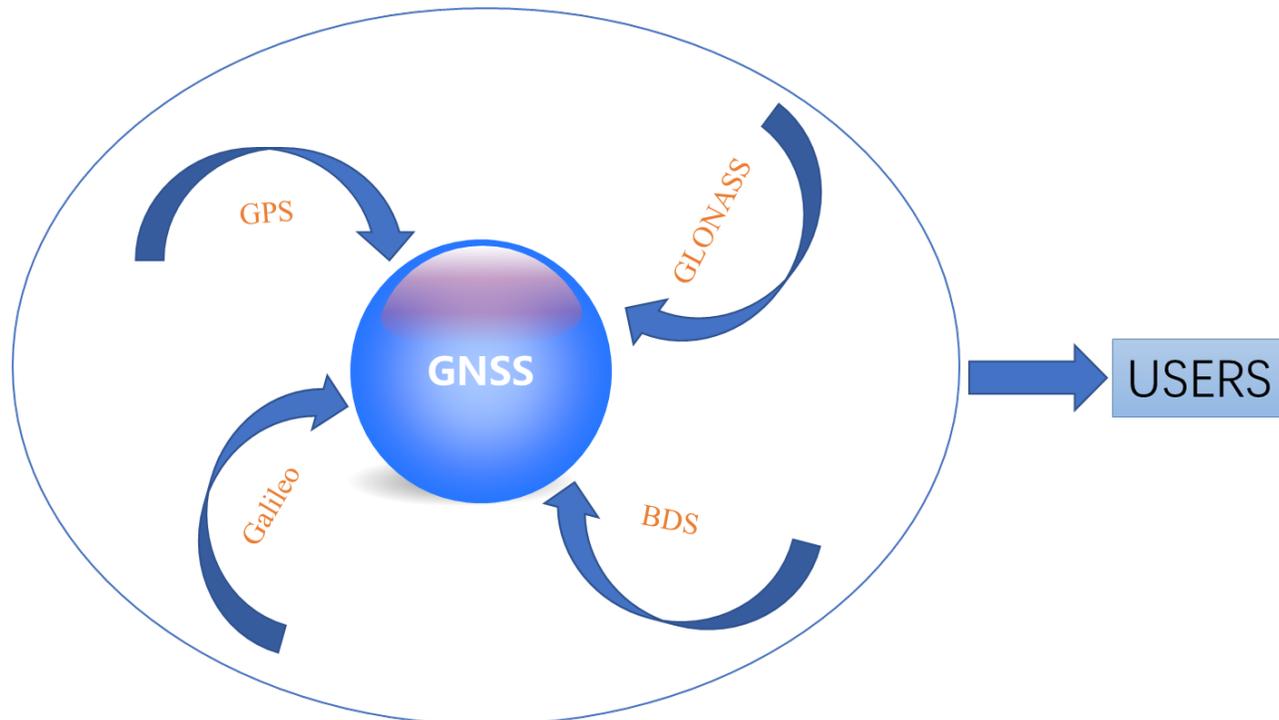
National Time Service Center, CAS

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The Content of Report

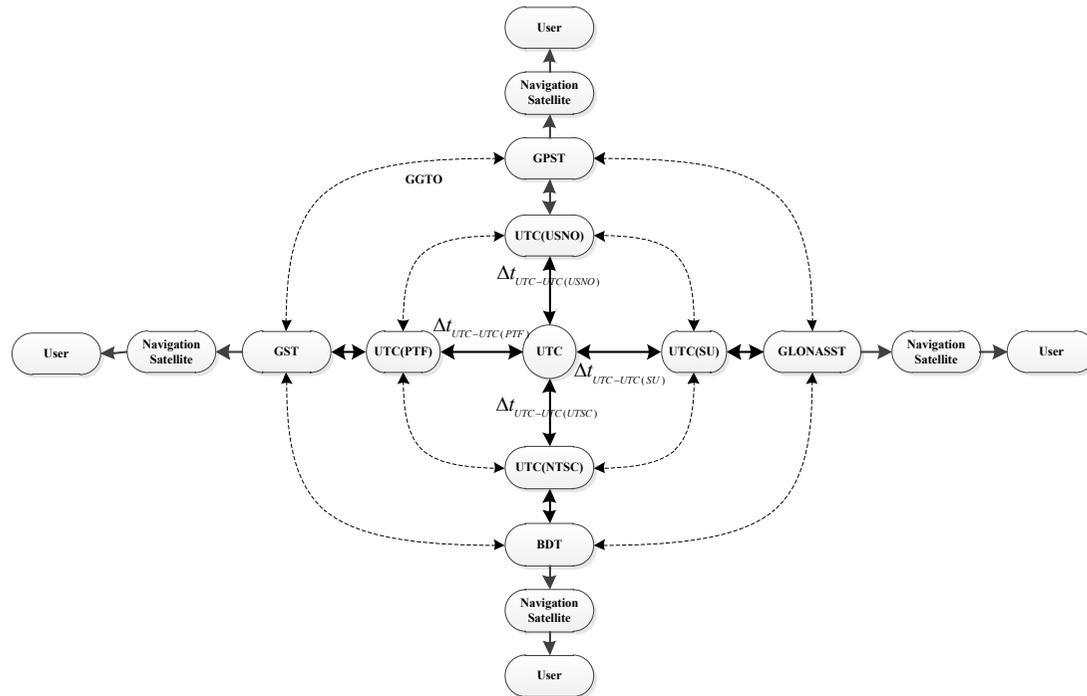
- ✓ **Background**
- ✓ **Principle of GNSS time difference Monitoring**
- ✓ **Some New Results**
- ✓ **Summary**

1. Background



- (1) Necessary for GNSS compatibility and interoperability.
- (2) Will improve the consistency of time service by GNSS.
- (3) Improve the responsibility of GNSS provider .

1. Background



Relationship of GNSS time and UTC

Although all the GNSS system time are steered to UTC, the time difference between them can not be ignored.

Such as the users $<100\text{ns}$

Which time is the most accurate? Time from GPS/GLONASS/GALILEO or BDS



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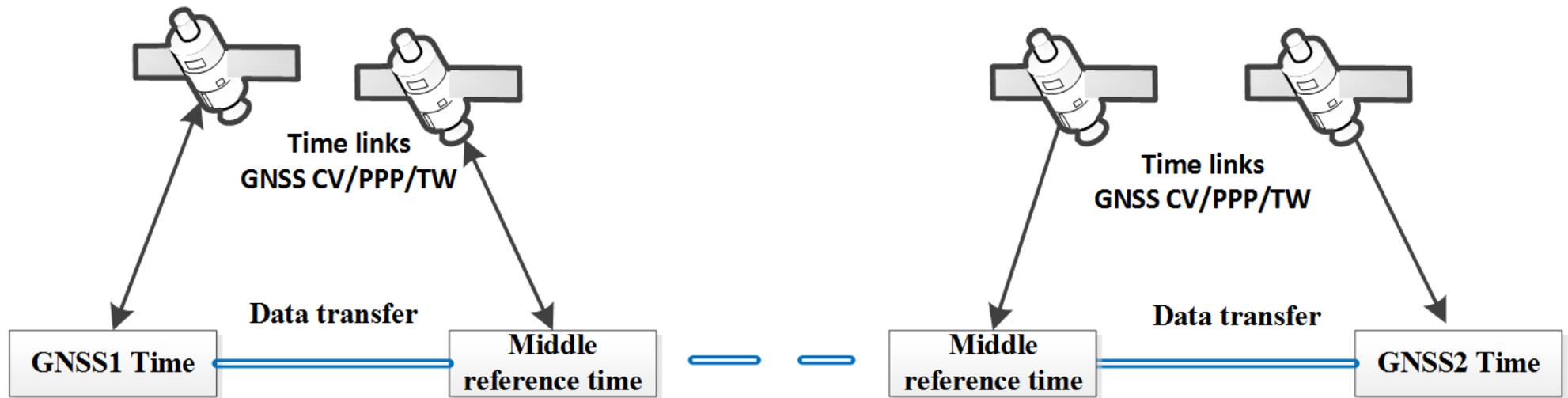
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2.Methods for GNSS time difference monitoring

- a) Time-link method
 - Time links(TW,PPP,etc.) between GNSS time center
- b) Single Station method
 - High performance GNSS receiver
- c) Multi-Station method
 - Many stations with GNSS high performance receiver

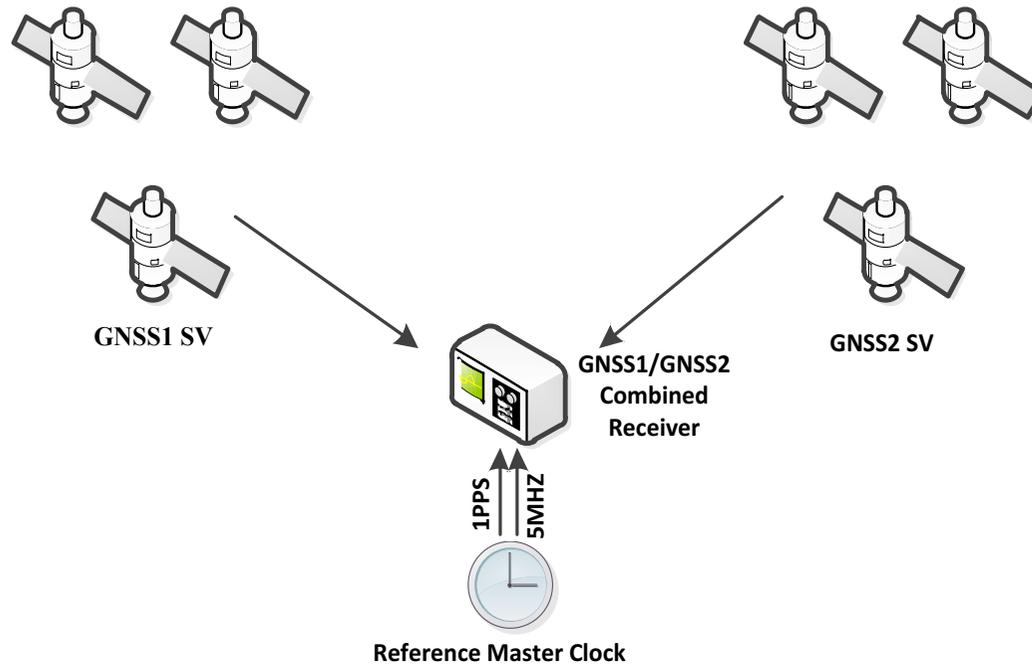
2.1 The Principle of Time-link GNSS Time Difference Monitoring

Time links between GNSS time center



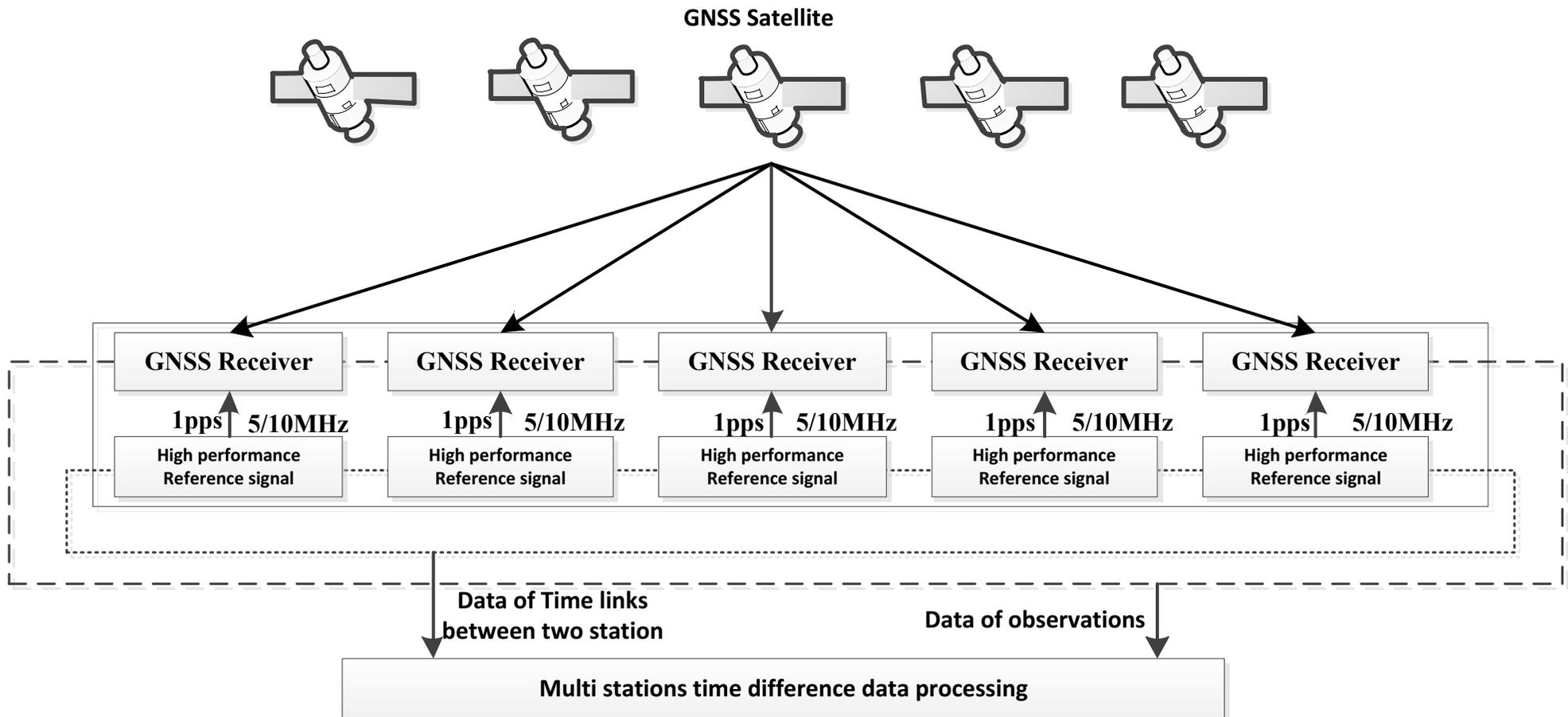
GLONT--domestic time links--UTC(SU)---international time links--UTC(NTSC) --domestic time links--BDT

2.2 The Principle of Single Station GNSS Time Difference Monitoring



- High performance GNSS receiver
- Real time data of RefT-GPST , RefT-GLONASST, RefT-BDT, RefT-GST
- GPST-BDT, GLONT-BDT, GST-BDT,.....

2.3 The Principle of Multi Stations GNSS Time Difference Monitoring



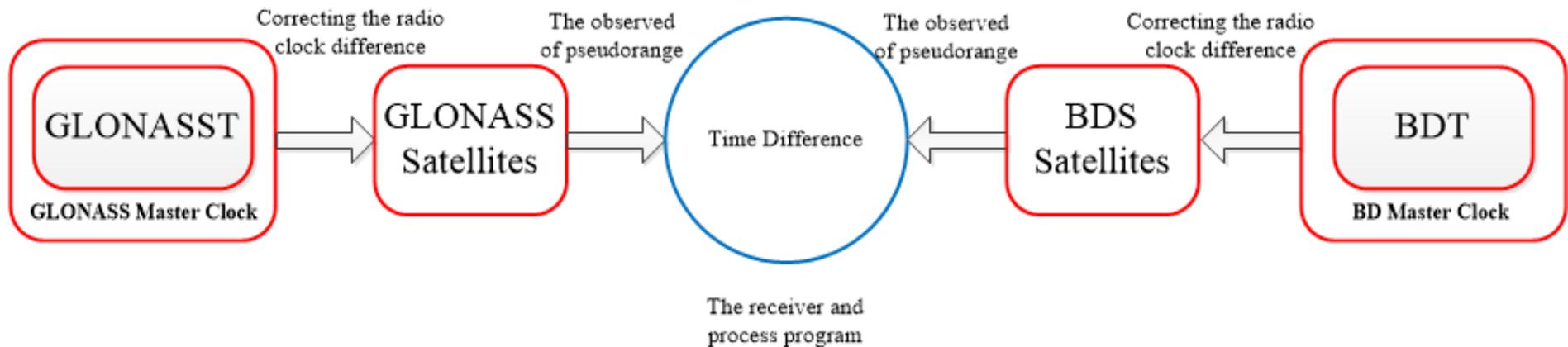
Ref1T-GNSS1T Ref1T-GNSS2T...

Ref2T-GNSS1T Ref2T-GNSS2T...

Ref1T-Ref2T(time links), average the results, GNSS1T-GNSS2T

2.5 GLONT and BDT monitoring

Example: BGTO (Time offset of the BDT and GLONT)



The RefGLONASS、RefBDS are the time difference between local time and the navigation satellite system, then the time difference between two navigation satellite system can be calculated by:

$$\text{GLONT-BDT} = \text{RefT-BDT} - (\text{RefT-GLONT}) = \text{GLONT-BDT}$$

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Some New Results

- Time links between two GNSS and time links calibration, TW/GNSS PPP/CV/ FB...
- Single station, receiver calibration
- Multi station, receiver and time links calibration
- The new experiments date:
Sept. 22, 2017 to Oct. 22, 2017.

SU: Institute of Metrology for time and space, VNIIFTRI of Russia , UTC(SU)

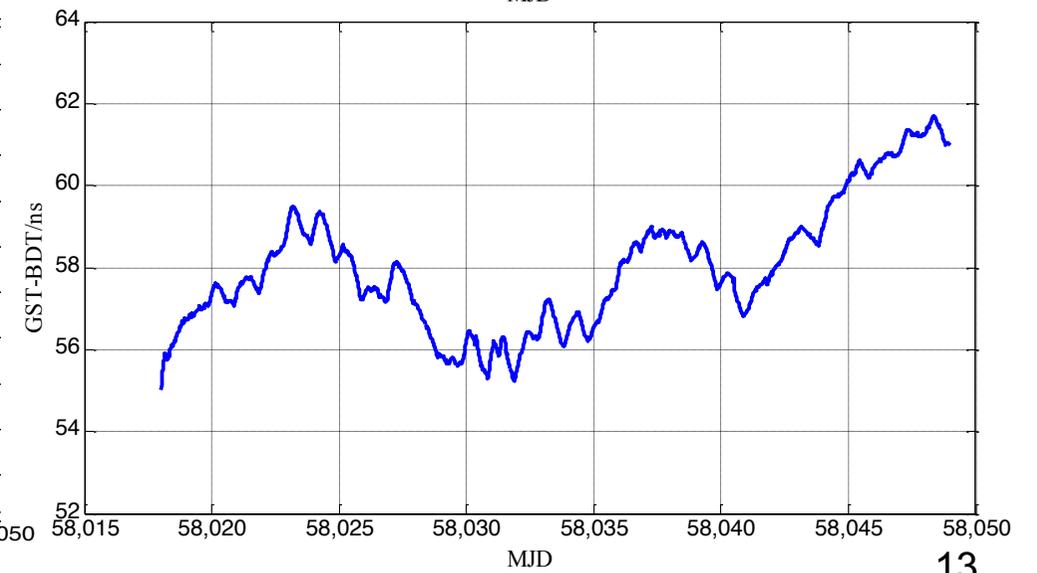
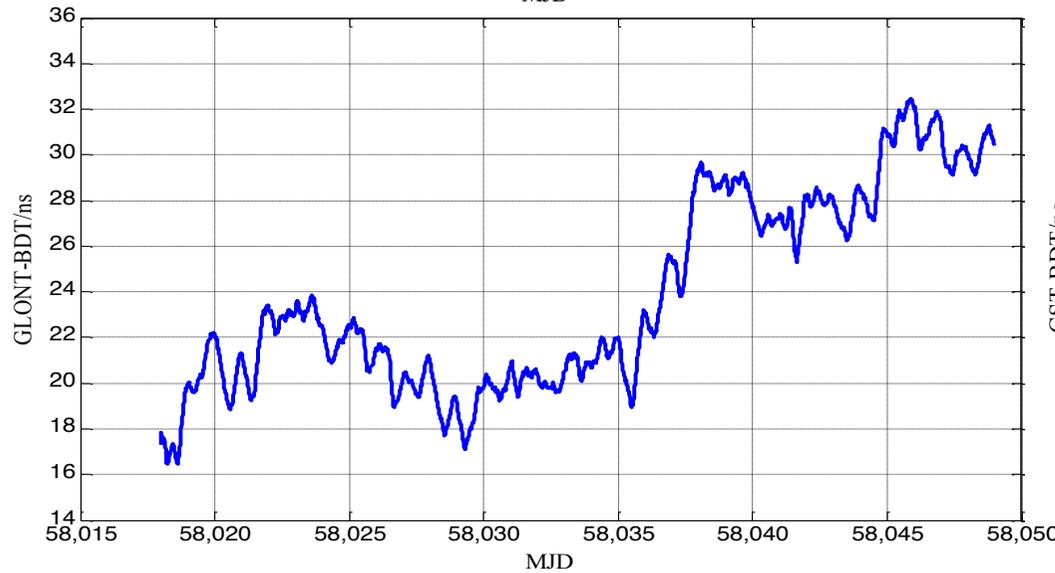
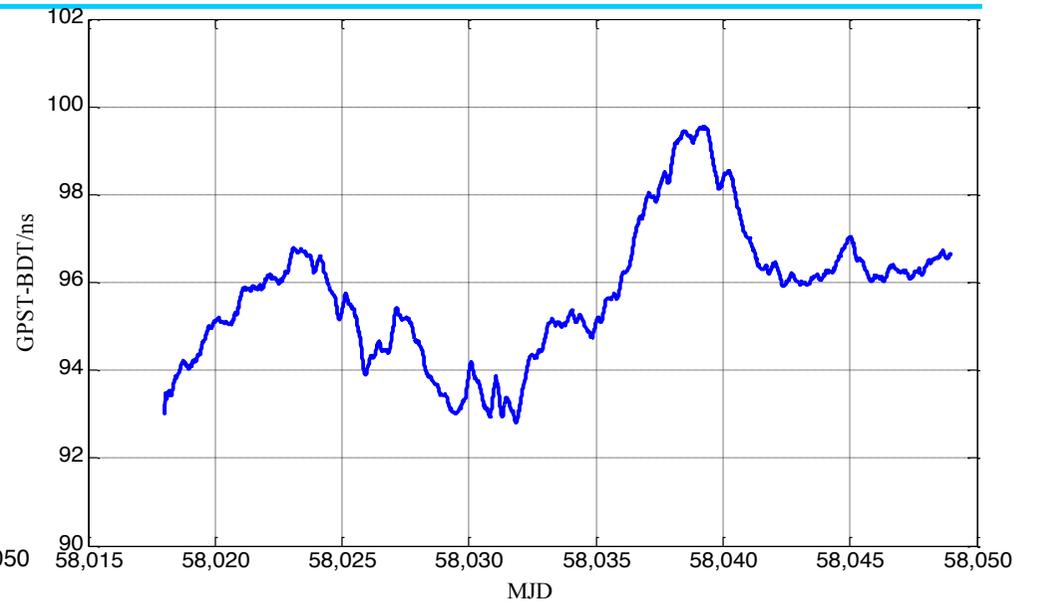
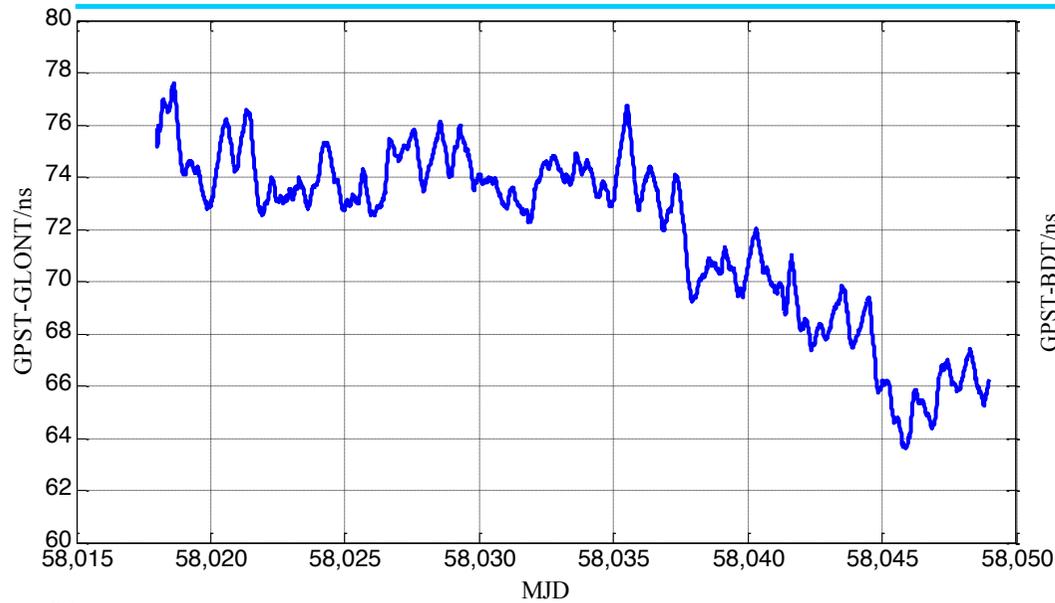
SP: Swedish National Testing and Research Institute, UTC(SP)

NTSC: National Time Service Center, China, UTC(NTSC)

TL: Telecommunication Laboratories, China, UTC(TL)

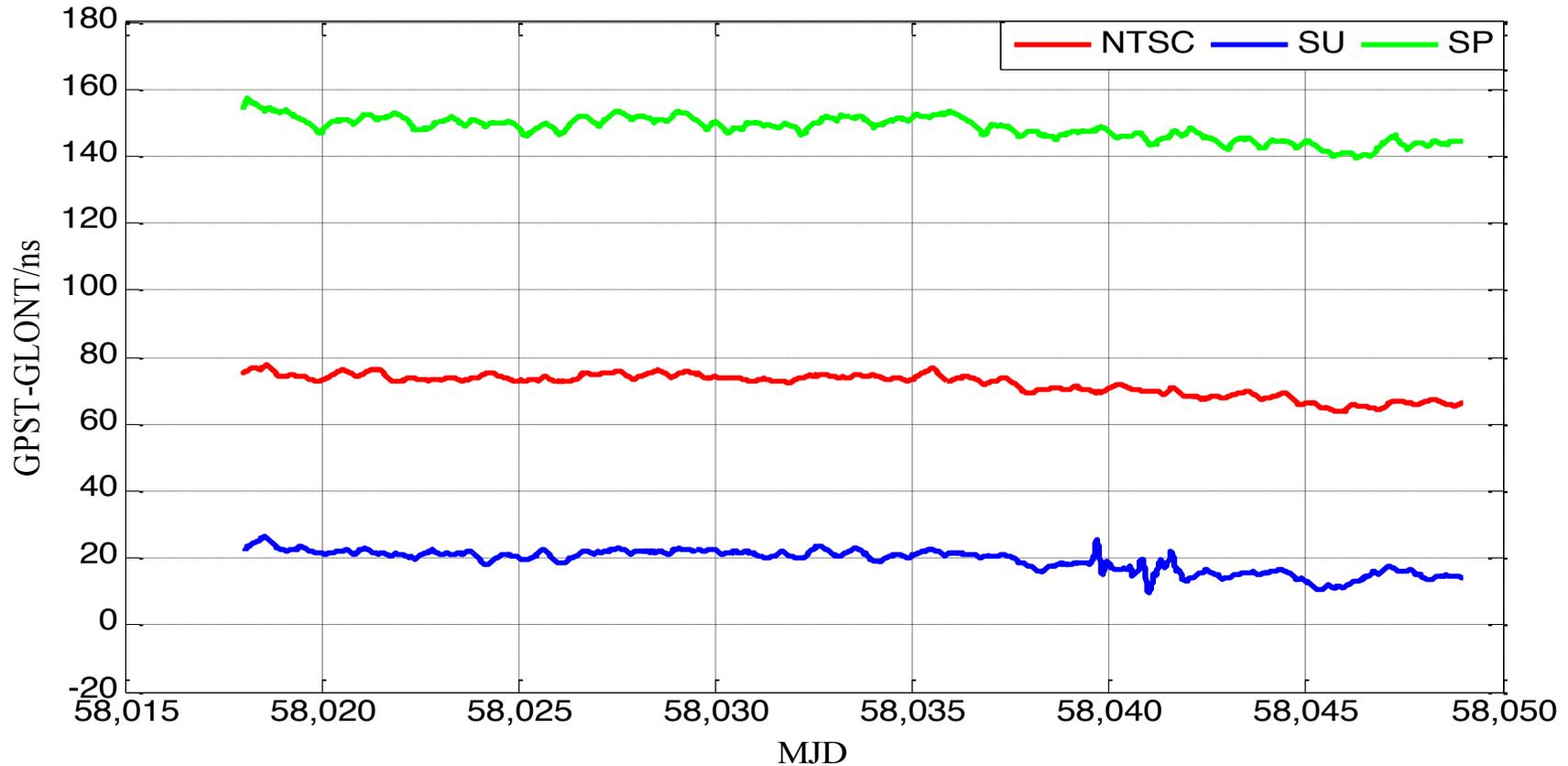
3. Some New Results

The time differences between GNSS systems monitored by NTSC



3. Some New Results

The result of GPST-GLONT by different monitoring station

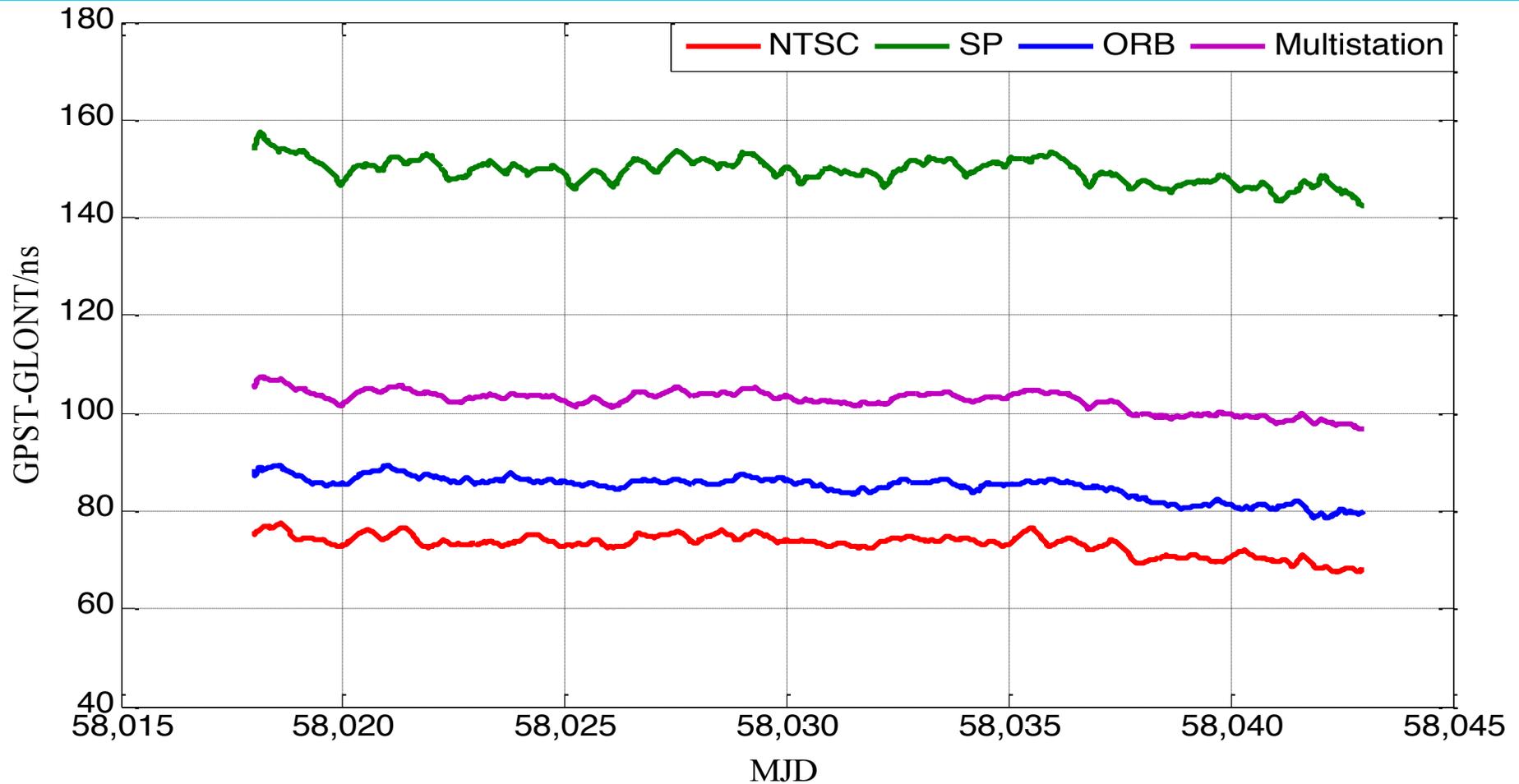


Similar data trends, large constant deviation

Receiver calibration is very important!

3. Some New Results

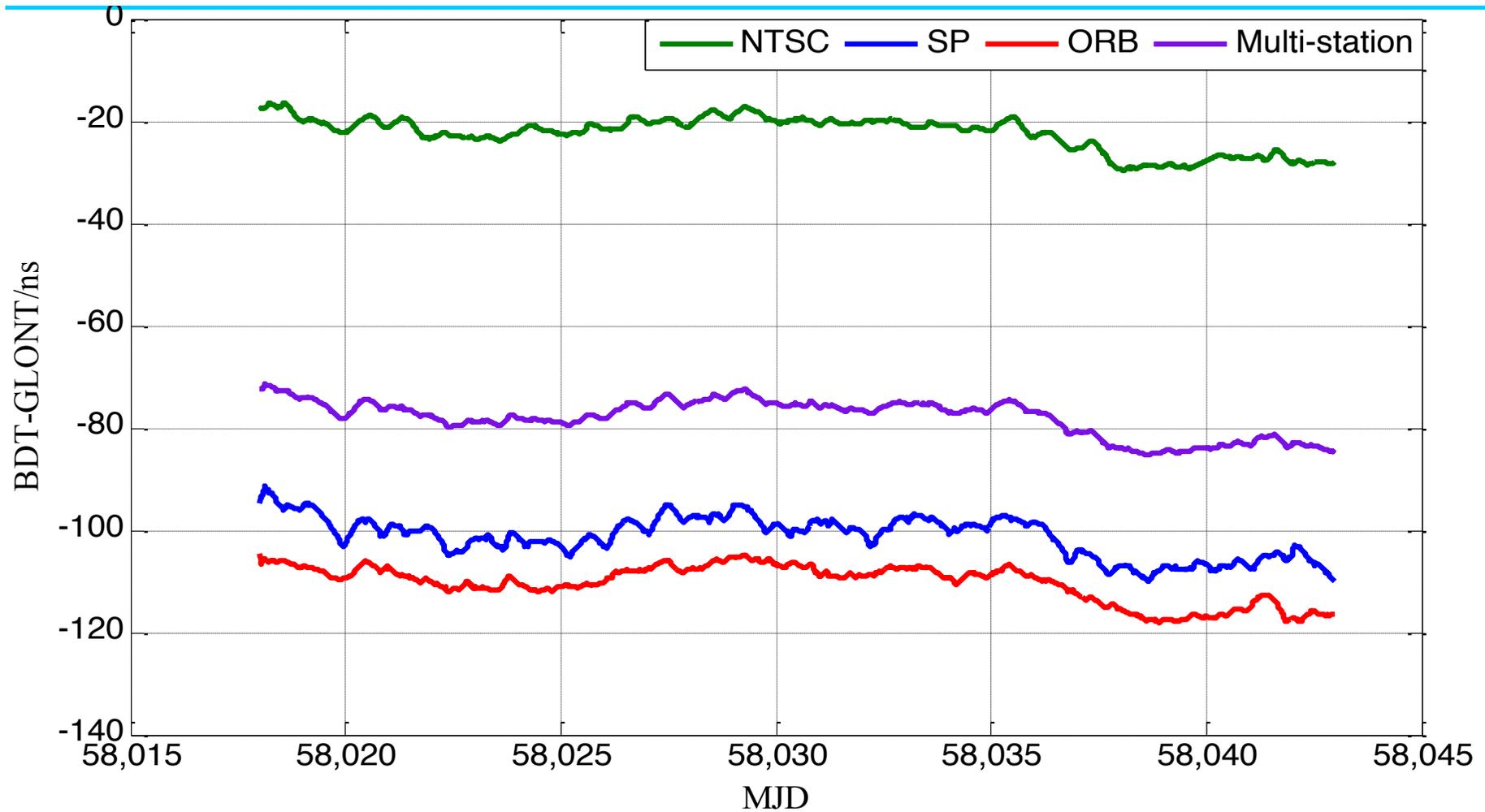
Multi-station monitoring (GPST-GLONT)



	NTSC	SP	ORB	Multi-Station
STDEV(ns)	2.0796	2.4917	2.3884	2.1820

3. Some New Results

Multi-station monitoring(BDT-GLONT)



	NTSC	SP	ORB	Multi-Station
STDEV(ns)	3.3531	3.9051	3.6270	3.5352

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4. Summary

- BDS has provided the time difference of BDT and GPST, BDT and GLONT in the test satellites last year, and will provide the formal time difference parameters in the BDS-3.
- 3 time difference monitoring methods, Different characteristics.
 - » Single Station method: real time, accurate
 - » Multi-Station method : not real time, more accurate, affected by data transfer link
 - » Time-link method: not real time ,the most accurate (to be studied more), affected by data transfer link

4. Summary

- The GNSS time difference prediction model should be studied.
- More test should be done to check and verify the validity of the different method.
- The time links between GNSS ground time center can be used to verify the results.
- Receiver and time links calibration are very important.



**Thank You for Your
Attention!**