ICG-5 ,Turin, Italy, Oct.17-22, 2010

# Definition and Realization of the System Time of COMPASS/BeiDou Navigation Satellite System

Chunhao Han

( hch203@163.com)

Beijing Global Information Center

(BGIC), Beijing, China

# Definition of BDT

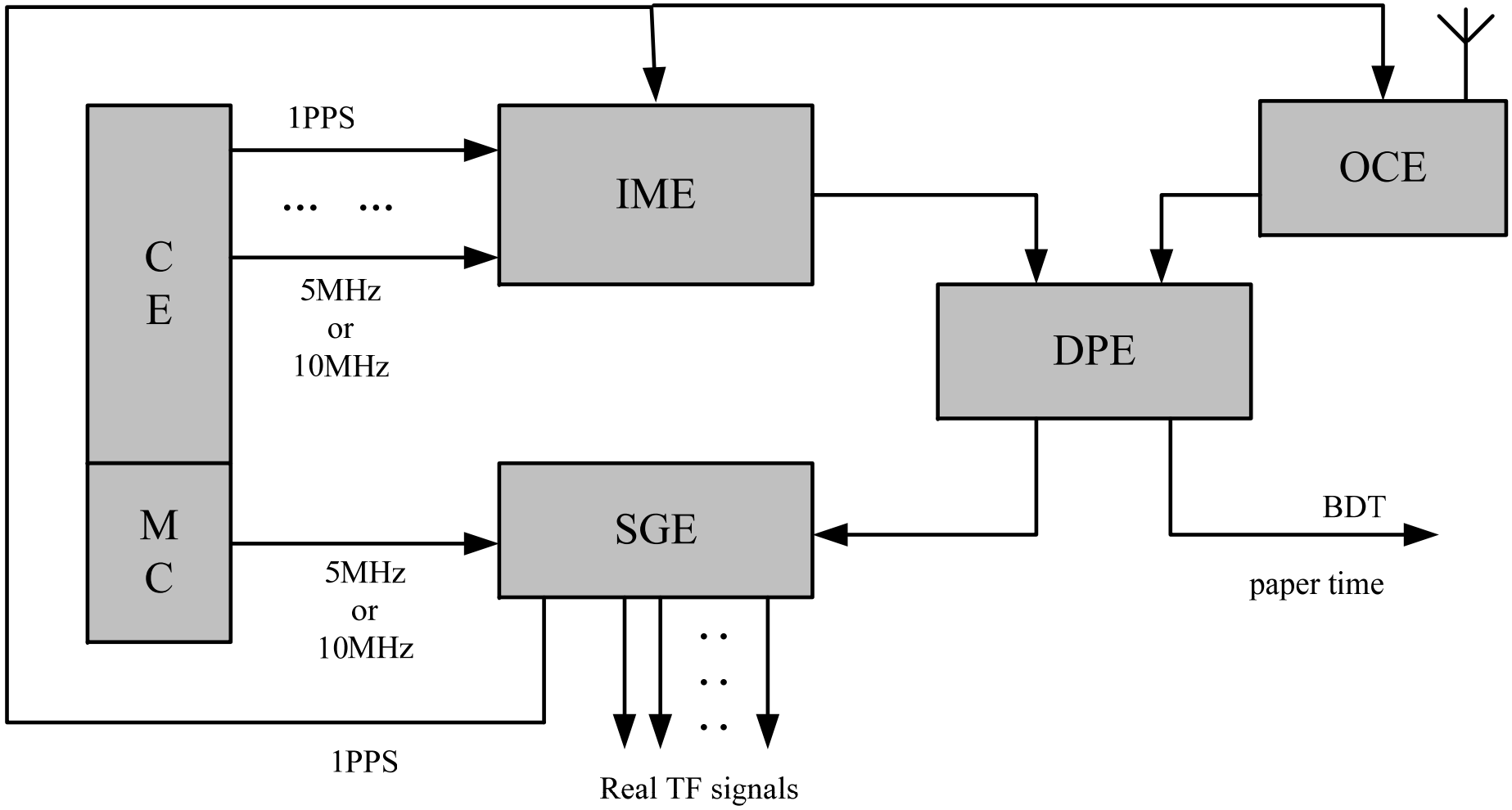
- The system time ( BDT ) is an internal , continuous navigation time scale, without leap second
- The basic unit is the SI second
- The largest unit used to stating BDT is one week, defined as 604,800 seconds
- BDT is counted with the week number (WN) and the second of week (SoW)
- The zero point is 1 January 2006（Sunday） UTC 00h00m00s

# Realization of BDT

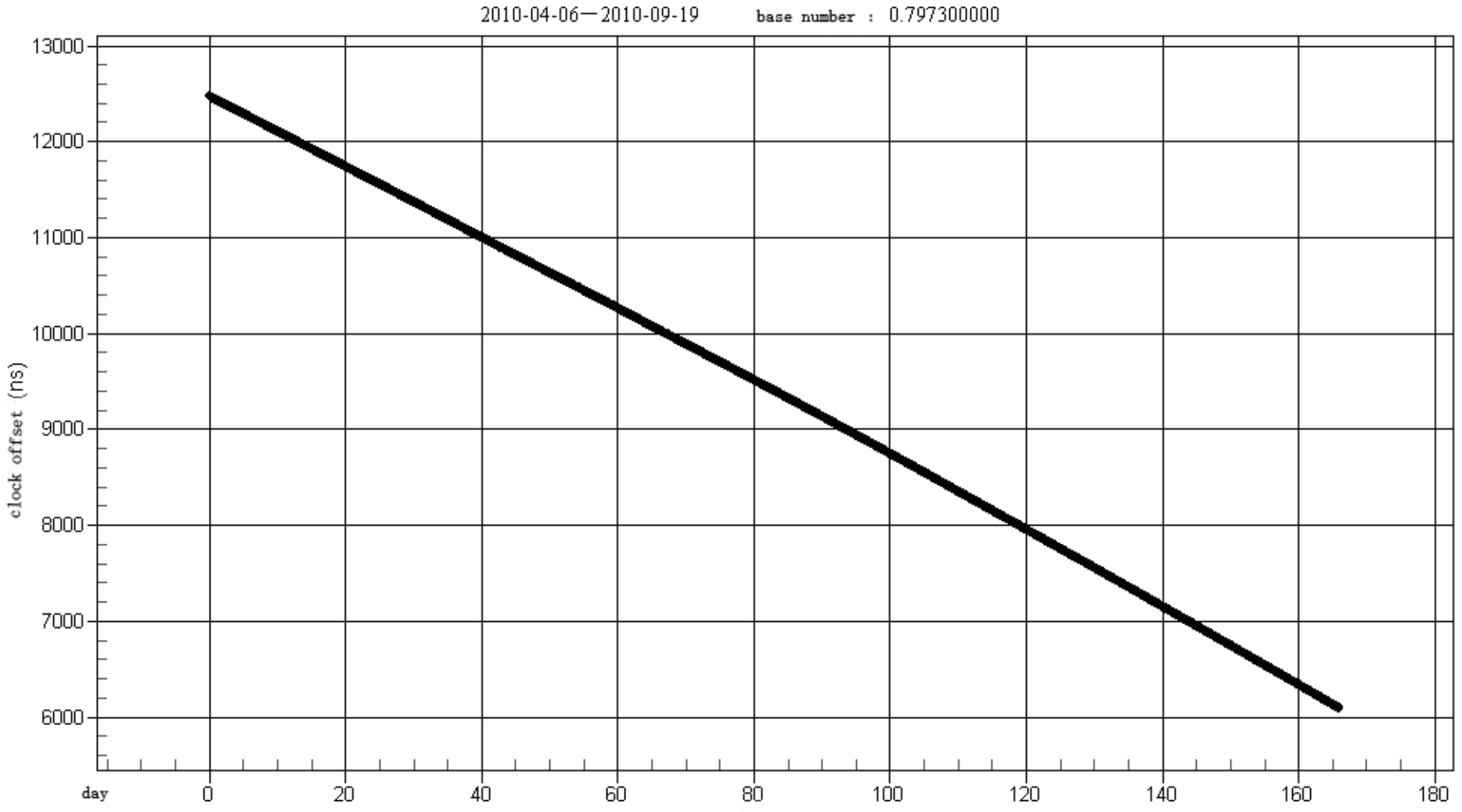
- **BDT is realized in a conception of composite clock**

- **BDT is maintained by a time and frequency system (TFS) located at the master control station (MCS)**

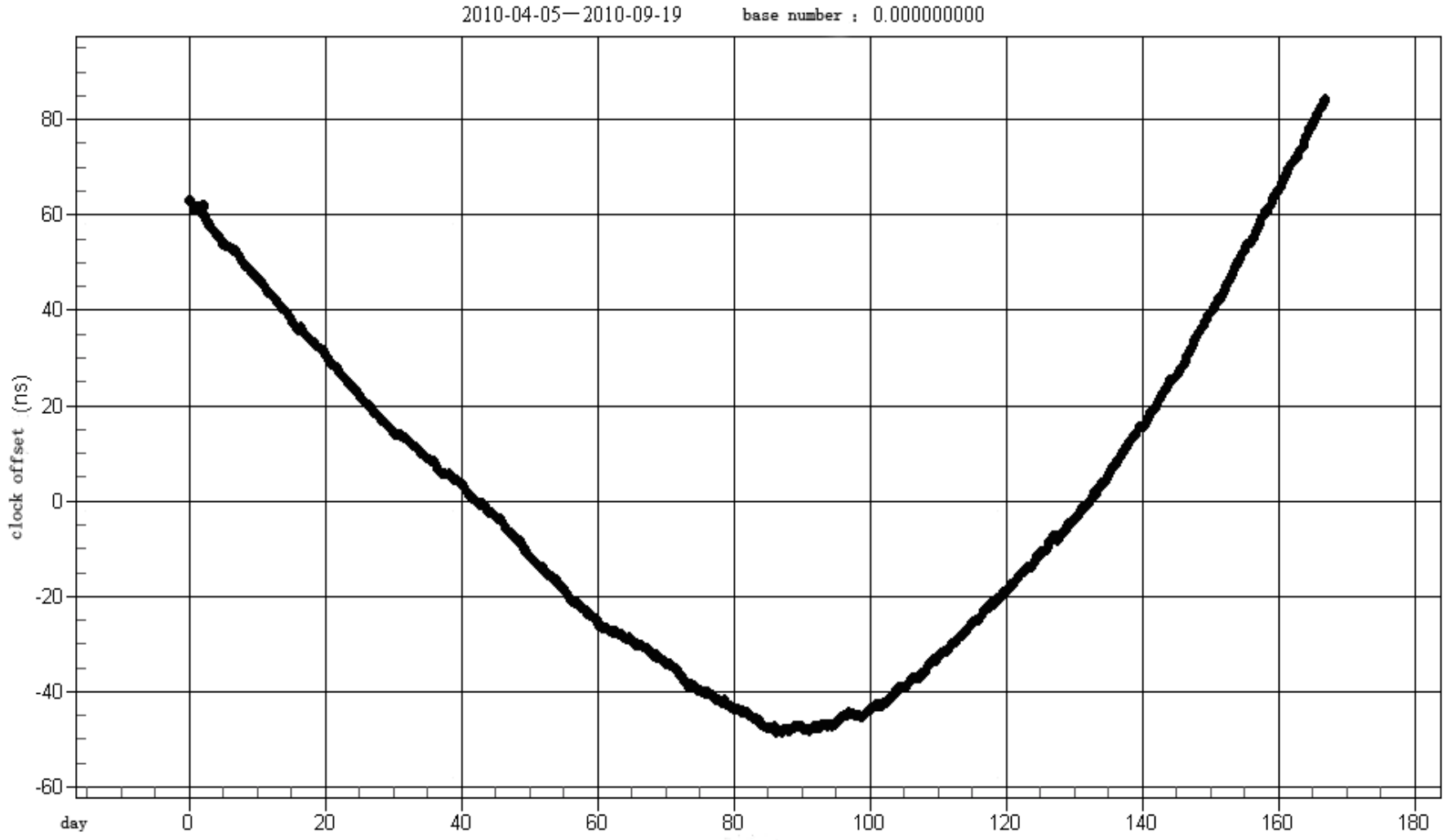
# Structure of TFS



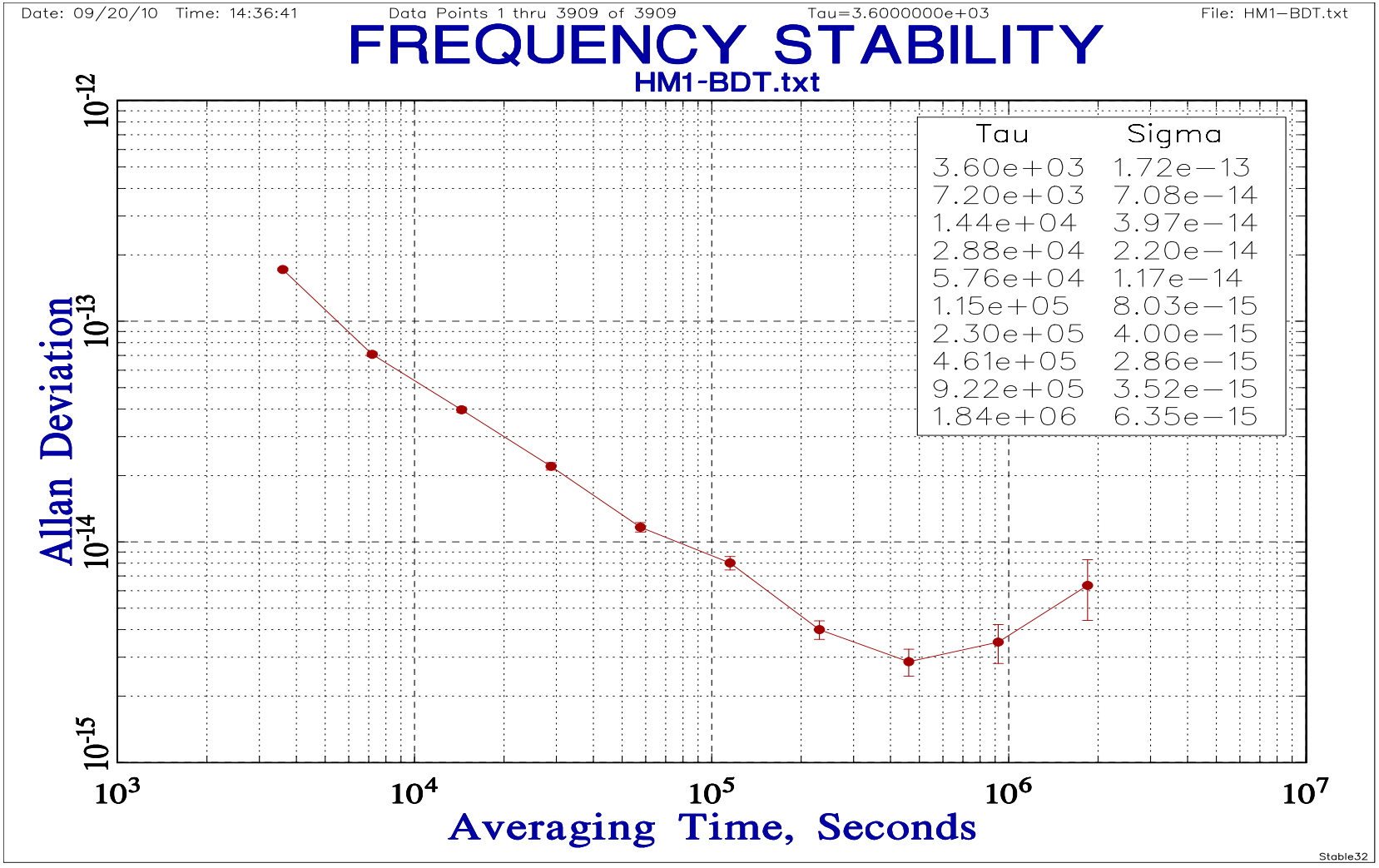
# Time deviation of a hydrogen clock referred to BDT



# The clock deviation deducted with the frequency offset



# Frequency stability of the clock



# Performance of TFS

**Time accuracy : $< 2\times10^{-14}$**

**Long stability : $< 1\times10^{-14}$ /1 day**

**$< 6\times10^{-15}$ /5 days**

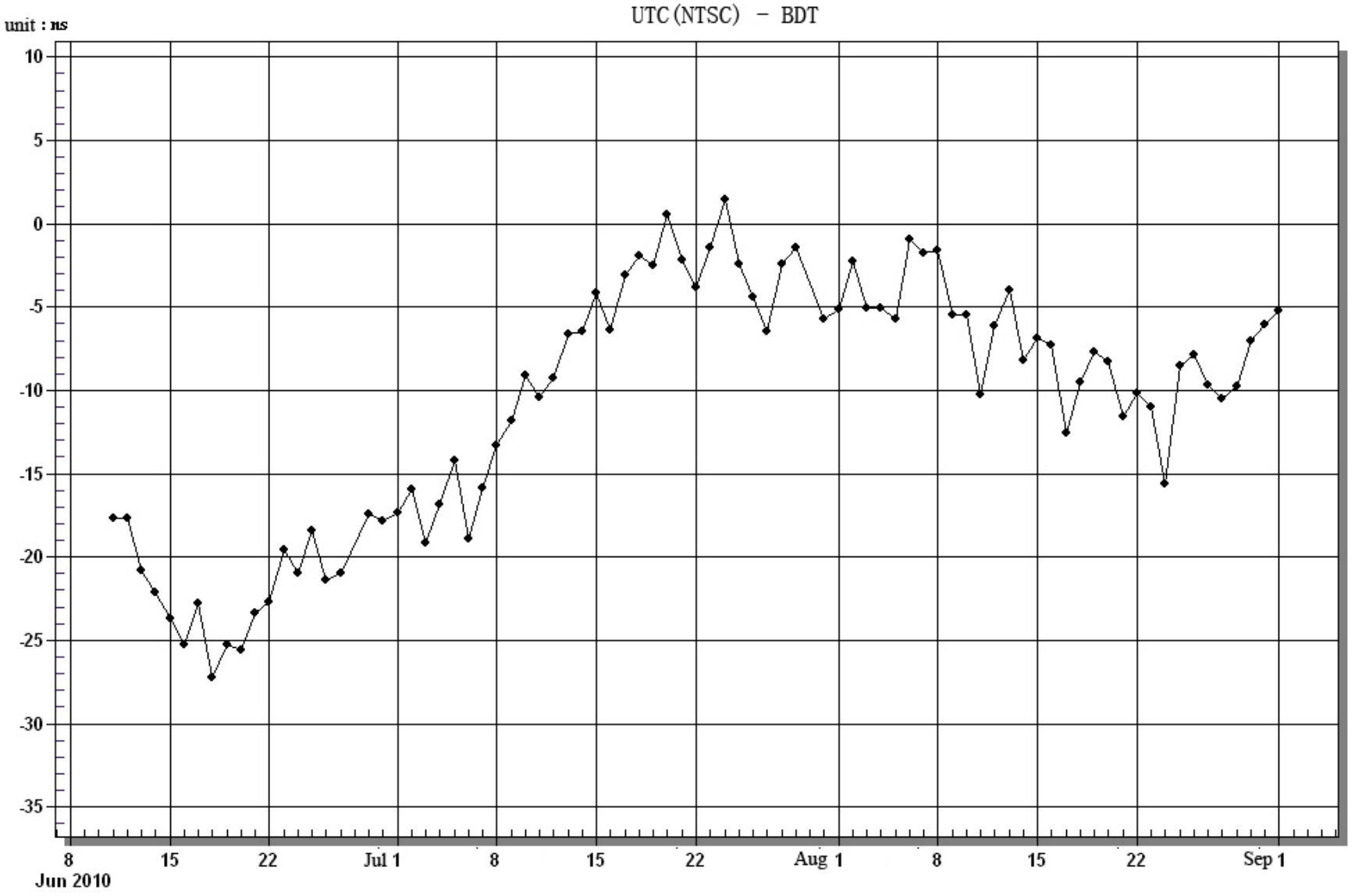
**$< 5\times10^{-15}$ /10 days**

**$< 6\times10^{-15}$ /30days**

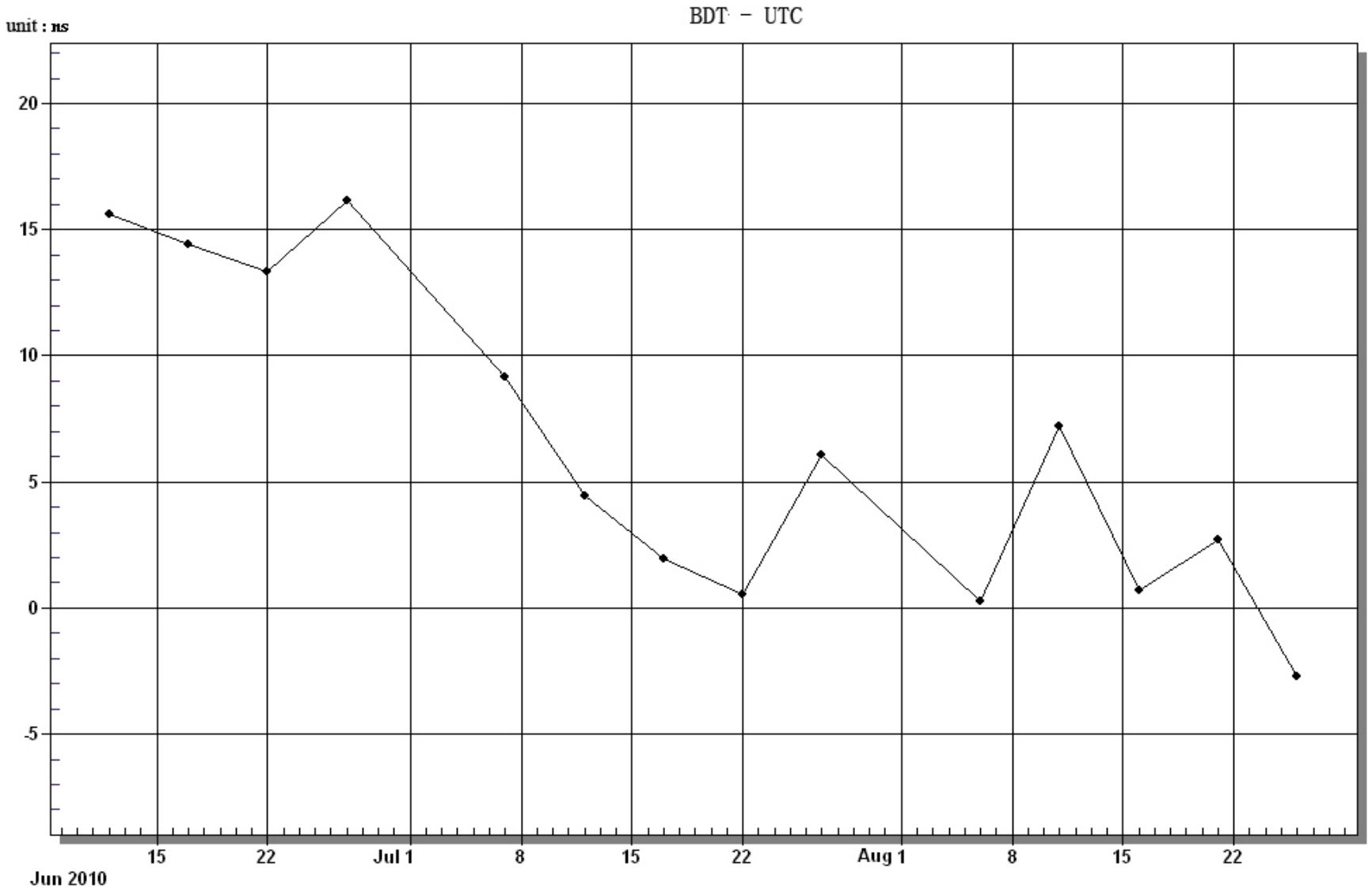
**Time deviation: |BDT-UTC| < 100ns**

**(modulo one second)**

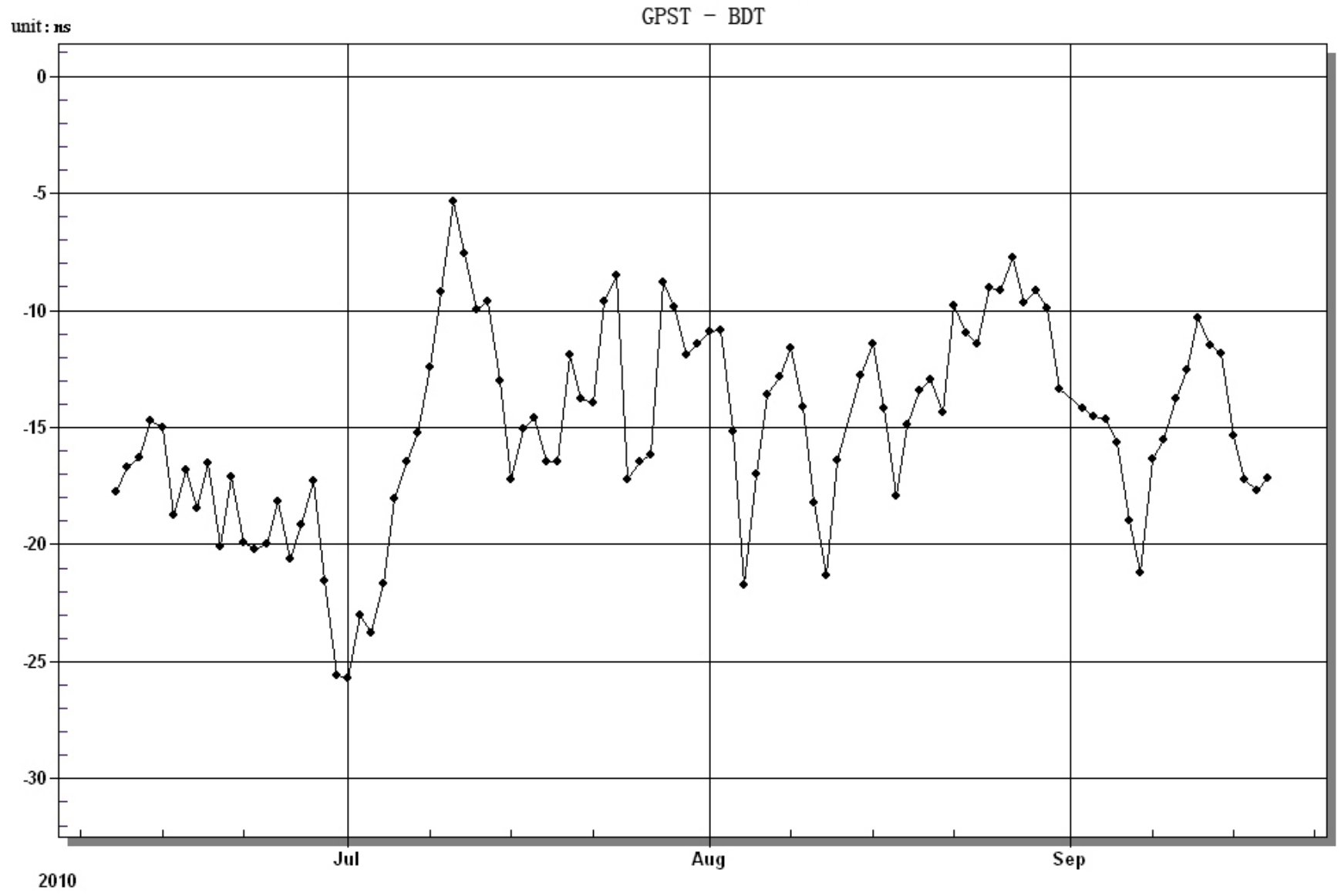
# Time difference between BDT and UTC（NTSC）



# Time offset of BDT with respect to UTC calculated Through UTC（NTSC）



# The observed time difference between BDT and GPST



# System Synchronizations

## Satellite time synchronization

- ✓ Two-way time and frequency transfer is used between satellites and ground stations
- ✓ Time prediction :

$$\Delta T \equiv T - t = a_0 + a_1(t - t_0) + a_2(t - t_0)^2$$

$a_0$, $a_1$ , $a_2$ and $t_0$ are given in the NAV data

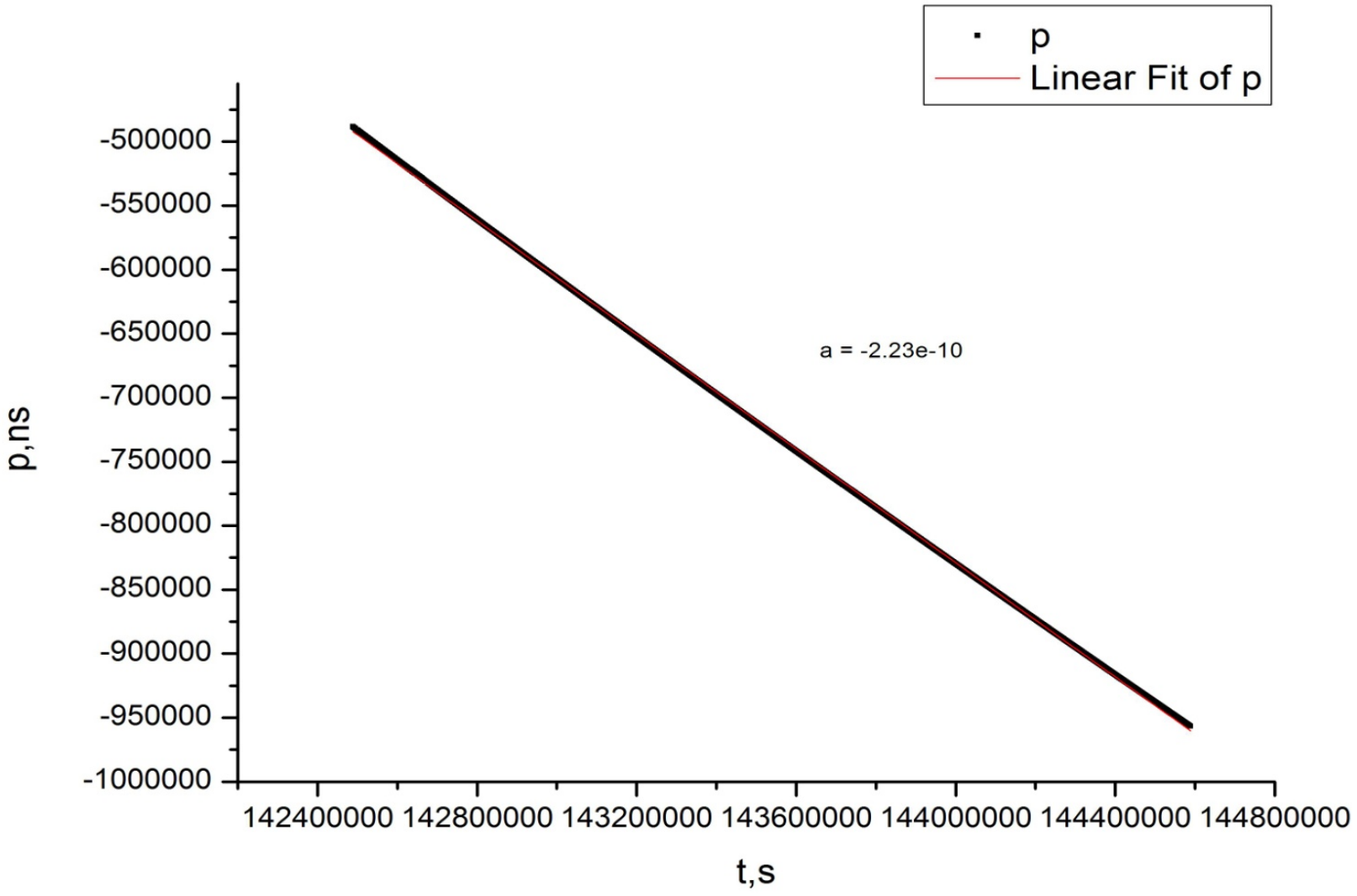
# System Synchronizations

## Station time synchronization

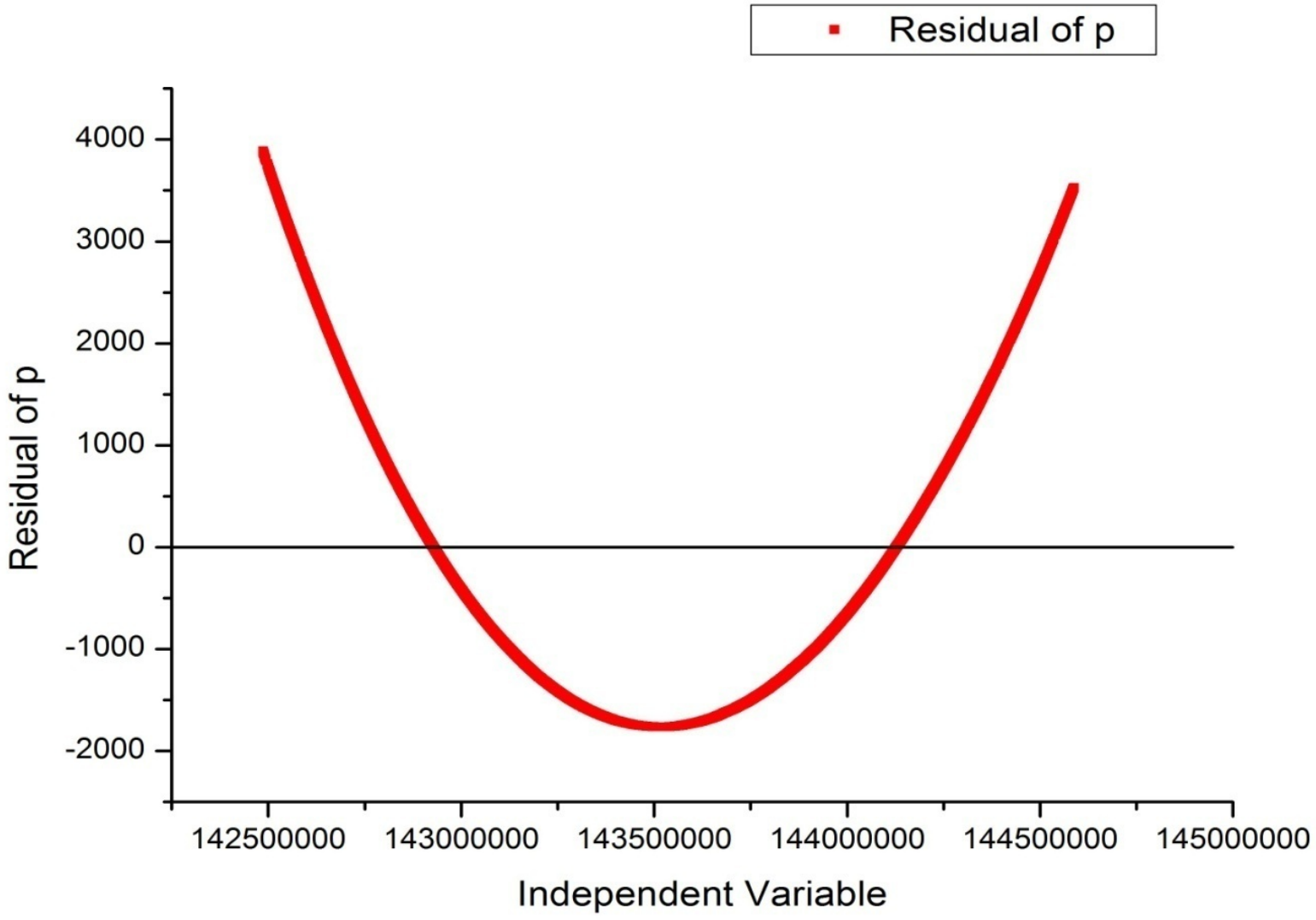
Two-way satellite time and frequency transfer (TWSTFT) are used between the master control station and the up-loading stations.

All the clock offsets are controlled within a limited range with the frequency and phase control.

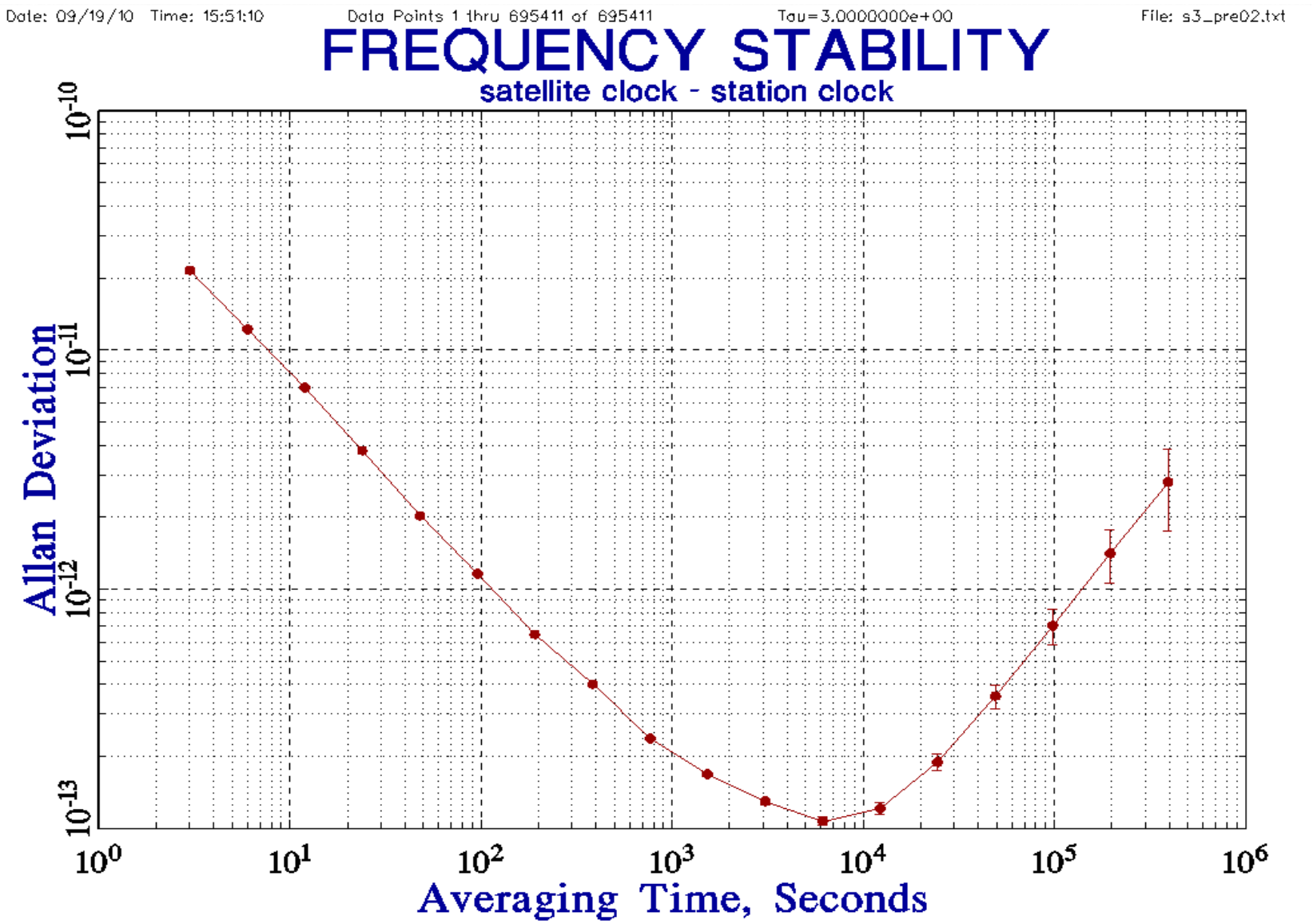
# The observed deviation of a satellite clock with respect to BDT



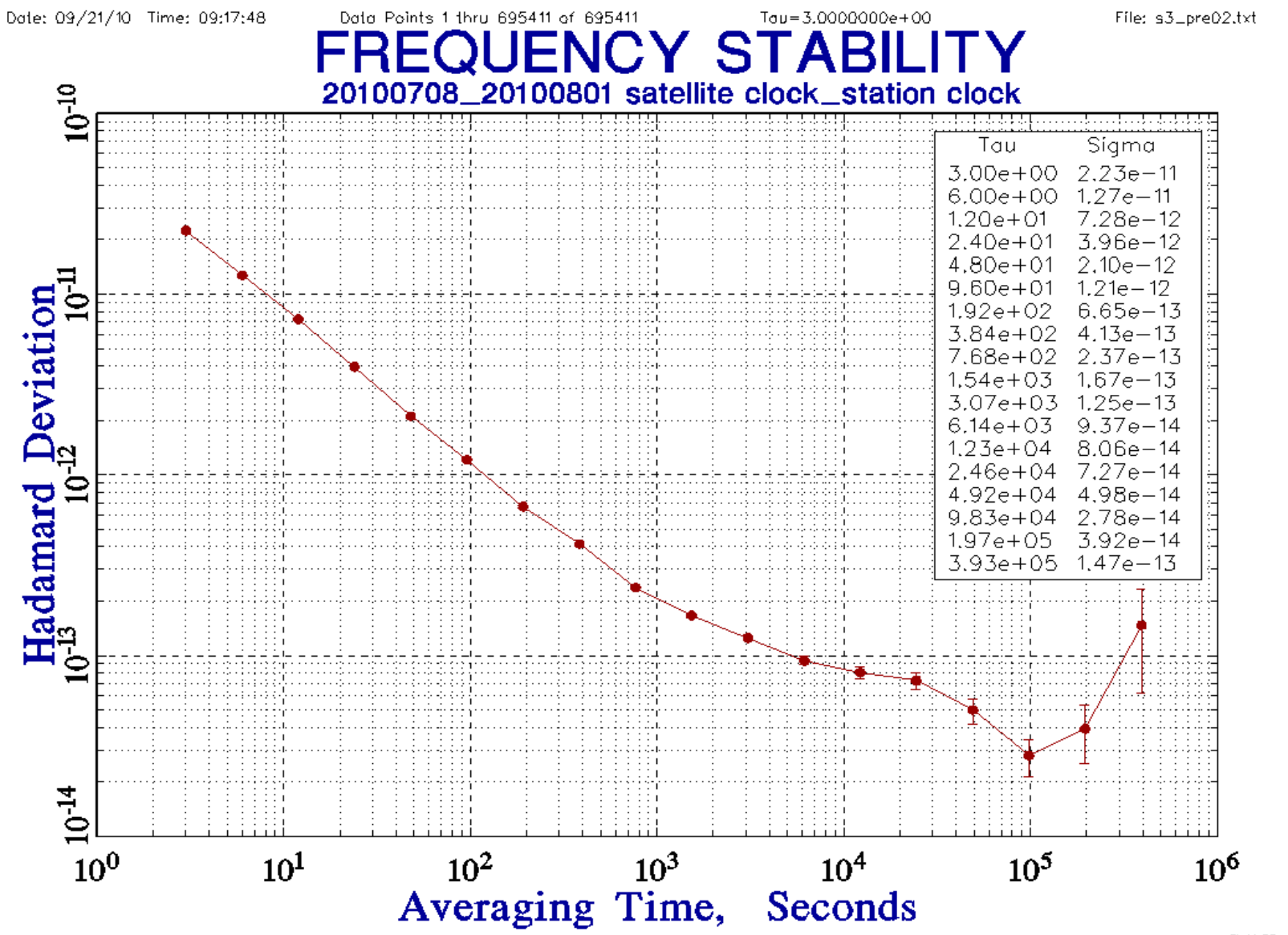
# The deviation of the satellite clock taken off the mean clock rate



# The observed Allan variance of the satellite clock



# The Hadamard variance of the clock



# BD Time services

- **RDSS one-way time service:**

  uncertainty :100ns → 50ns

  (referred to BDT)

- **RDSS two-way time service**

  uncertainty :20ns → 10ns

- **RNSS one-way time service**

  uncertainty : 50ns

# Improvements and developments

- ✓ **Accurate relation of BDT to UTC**
  - TWSTFT
  - Fiber time and frequency transfer
- ✓ **Long stability of BDT**
  - the time keeping clocks
  - the hardware and software of TFS

# Improvements and developments

- **GNSS time monitor system**

  observe the time differences

  calculate the system time offset

  broadcast the parameters in BD NAV data.


Thanks
谢谢!