USNO Station Report

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Jim Brad
Observatory of Paris
September 10-11, 2006

The Operations Team

Jim Brad

Angela McKinley

Alan Smith

Lee Breakiron

Mark Bergman (new)

John Hirschauer (new)

+ 1 more (vacancy)

The Indispensable Part-timers

- Bill Klepczynski
- Blair Fonville
- Wendy King
- Rest of USNO Time Service

Issues Being Addressed

- Use of carrier-phase GPS for low-cost calibration sanity checks
  - Breakiron et al: 1 ns RMS repeatability for TWSTT
  - Saves expense of semi-annual calibration
- Diurnal Elimination
  - Diurnals between USNO and AMC > 1 ns
  - Amplitude may be related to fiber connections from modem to antenna
  - Also to temperature

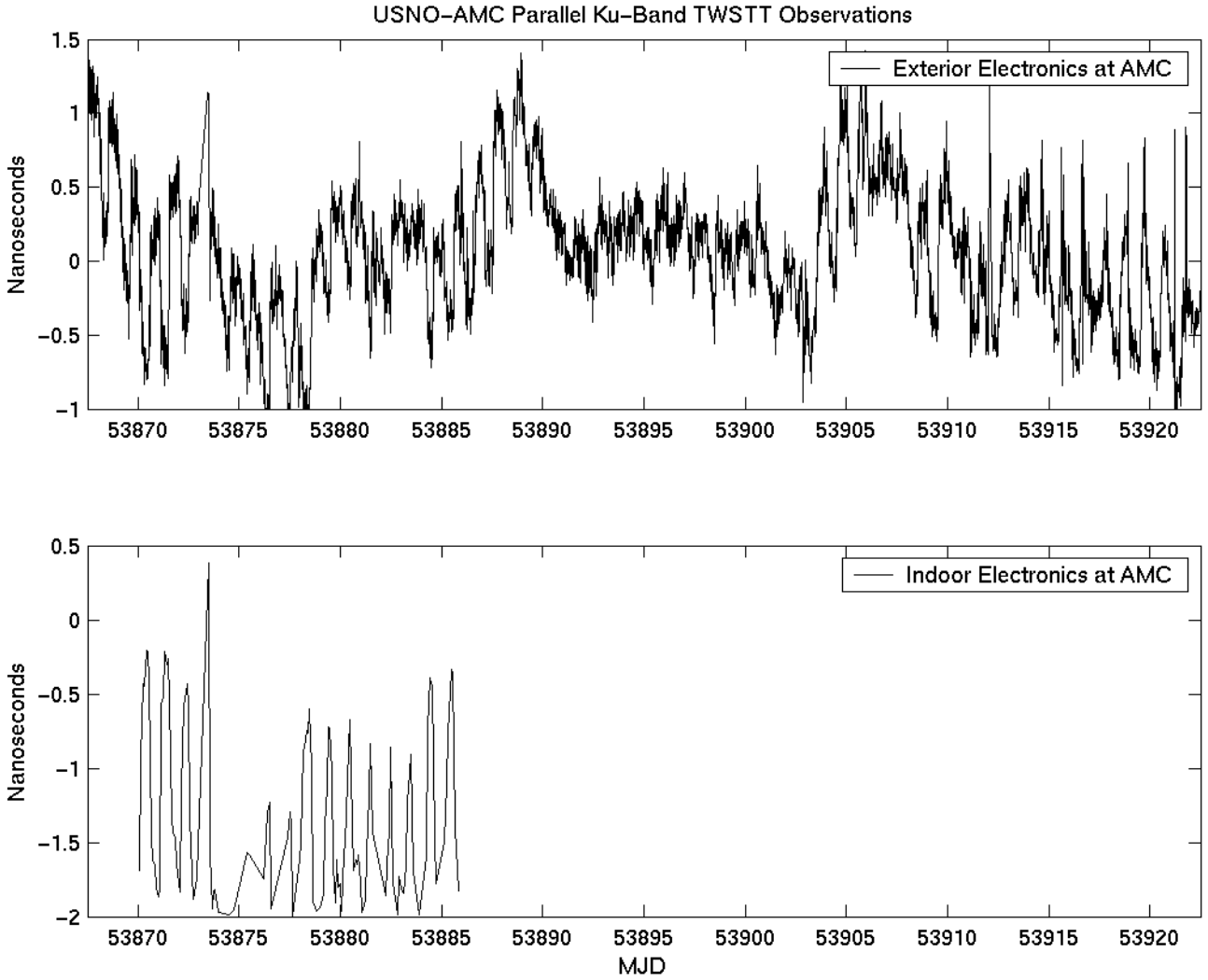
What we hope to do next year

- Set up station in Hawaii
  - Enable NICT-TL-USNO observations
  - Site visits, negotiations ongoing
- Test two Timetech Satsims
  - delivered last year
- Still in our dreams
  - High-bandwidth experimentation
  - Carrier-phase TWSTFT

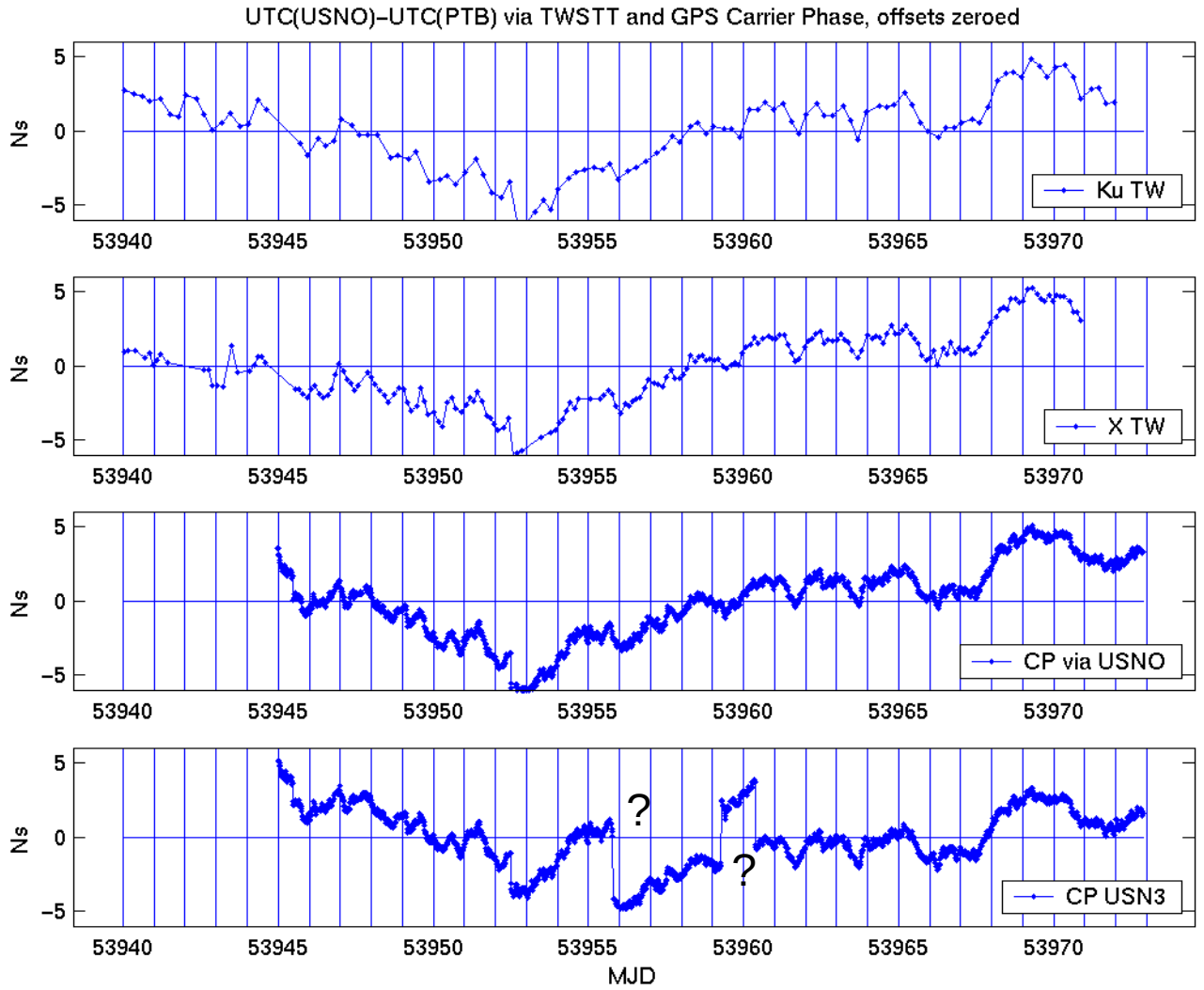
Issues With TWSTFT

- Budgets are shrinking
- But diurnals are not
  - They can be stronger in summer
    - Temperature extremes larger there
    - Got worse with this hot summer
    - Implies a limit to calibration accuracy
  - And they often show other dependencies
    - Cross-talk
    - Cable multipath
    - ?
  - They are sometimes a property of the link
    - Need masers to see them
  - Other times a property of the site equipment
    - Which means they appear on all links for the site

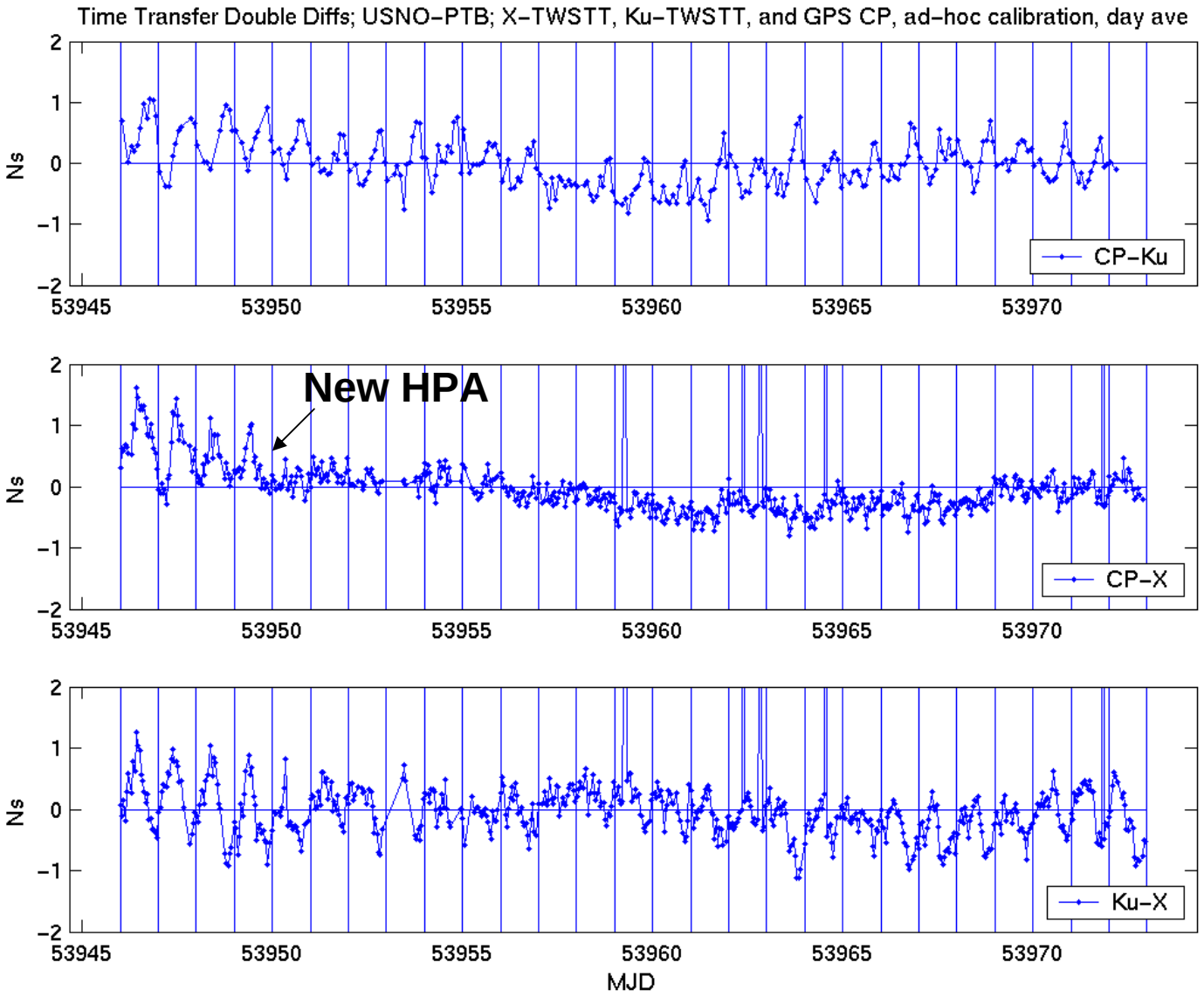
AMC Diurnals



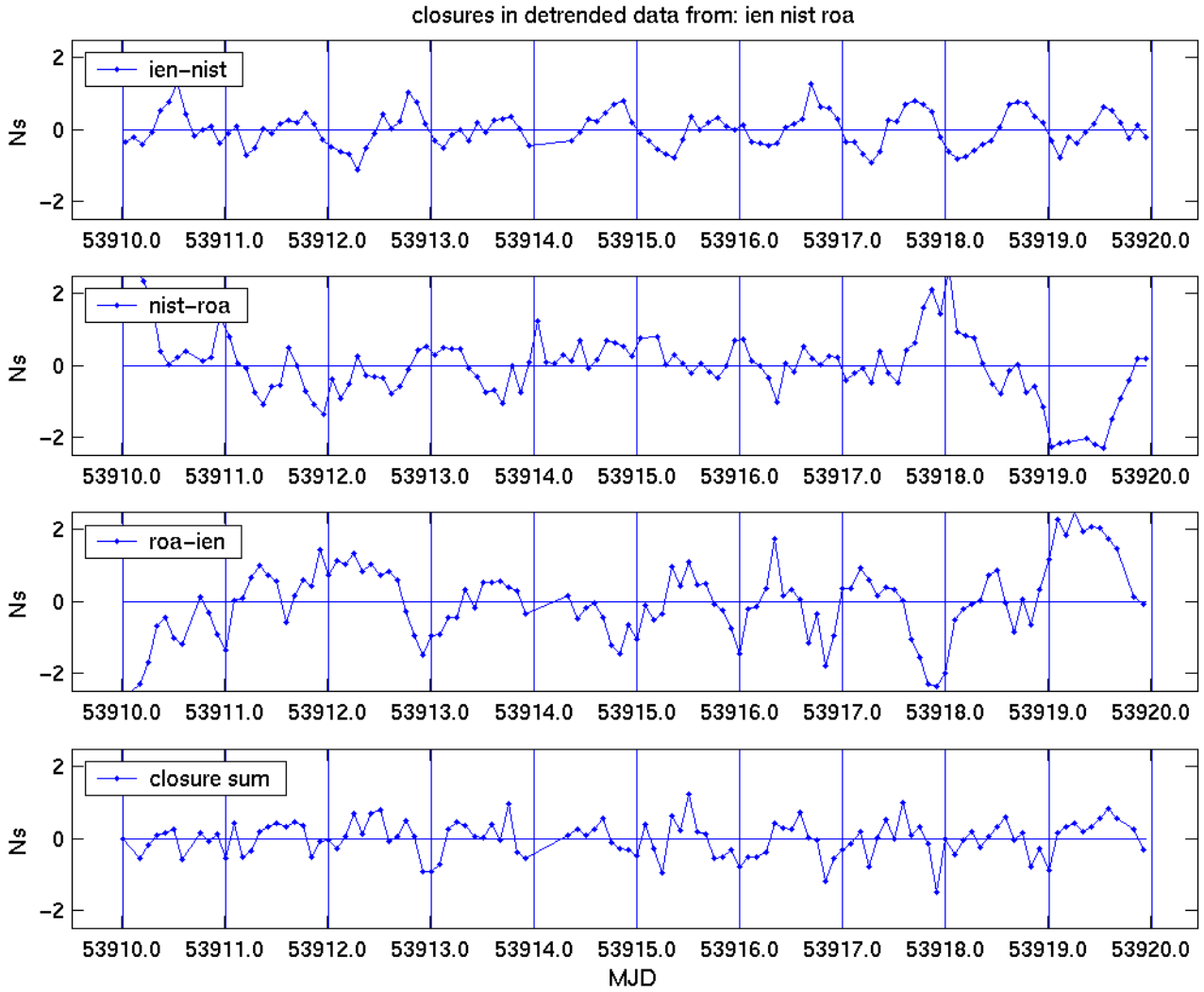
USNO-PTB via TWSTT and GPS



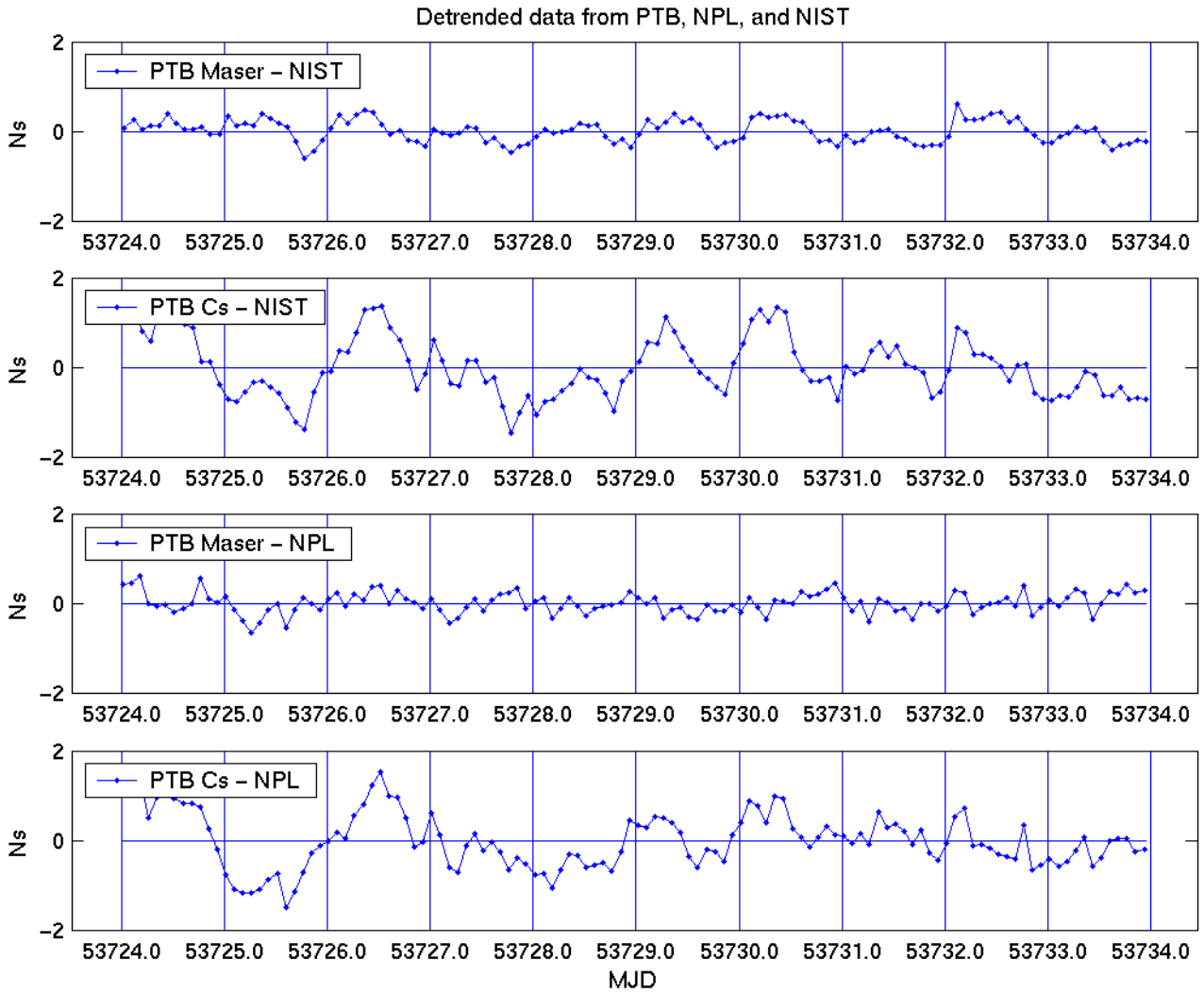
USNO-PTB Double Differences



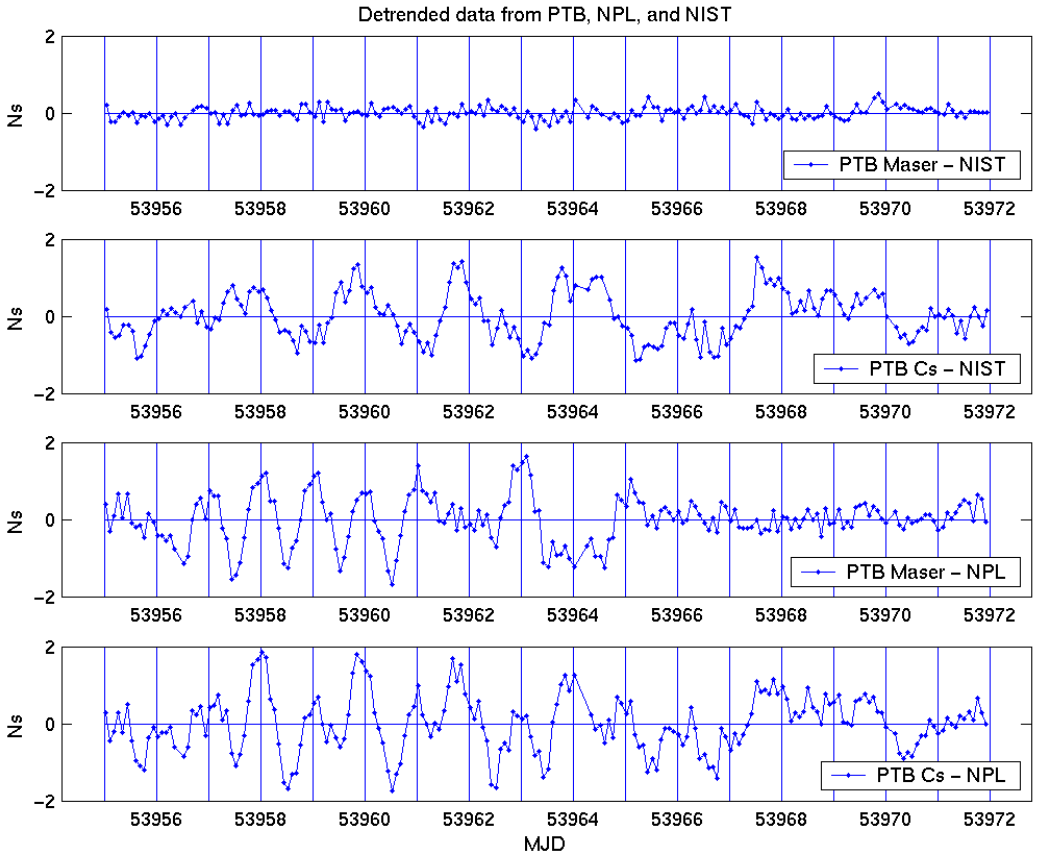
Diurnals may be link-based



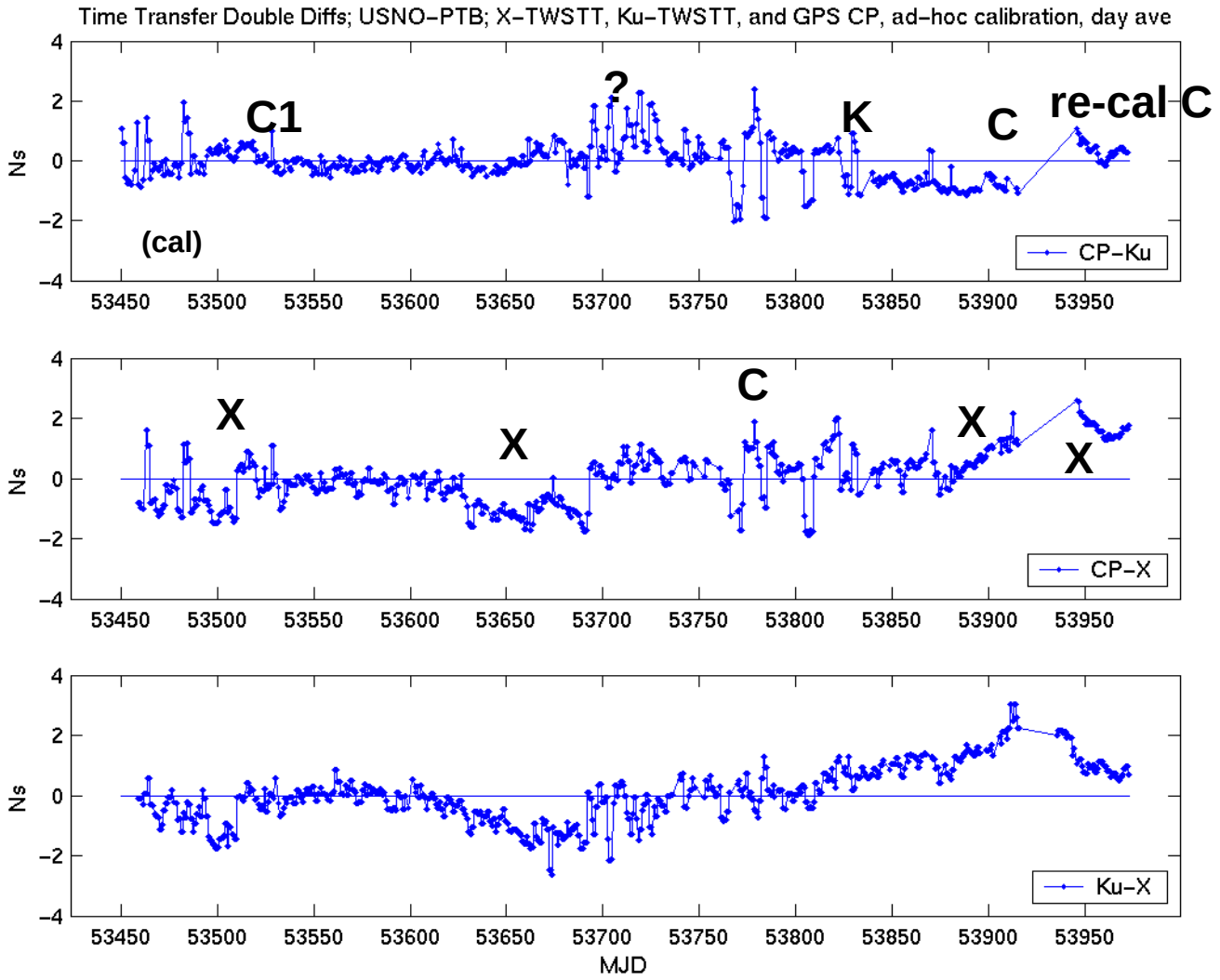
You Often Need a Maser



Good Data Exist



No Hardware is Perfect
K,X,C identify technique at fault (C=CP)



Advantages of Carrier Phase GNSS for TAI-Generation

- Low cost
- Trivial to operate hardware
- 20 ps precision @ 5 minutes !
  - Routinely produced as of the last several years
  - Significant improvements with new GPS and Galileo
- Accuracy just as good as TWSTFT
  - But you don’t lose calibration with satellite changes
    - Which seem to happen once a year

Drawbacks to Geodetic GNSS

- Data reduction more complex
  - But others will do it for free
    - USNO and IGS
    - JPL/AutoGipsy do it anonymously, on the web
      - Send them a rinex file, get a solution
      - But only for data > 10 days old
        - » But no one has pressured them for real-time
  - You can buy Bernese for $7,000 (or so)
  - Any computer-savvy mathematician can learn Bernese or GIPSY
    - Rolf Dach will do it, and special runs too, for 35,000 CHF/year
- Day-boundary jumps
    - Subnanosecond
      - Typically less than noise in TWSTFT
    - Understood
      - Due to systematics/noise in GPS code
    - Can be removed by any of several means

Geodetic GNSS Drawbacks (2)

- USNO Ashtechs Z12T's show 1 ns jumps every few months
  - TWSTT does this too, but far less frequently
  - So USNO has ordered 3 geodetic receivers
    - Javad ($14K)
    - NovAtel ($8.6K)
    - Septentrico ($13.4K)
    - Jerzey Nawrocki makes a good one too (TST)
- Receivers should be in environmental chambers
  - But we'd like to do that with TWSTFT hardware too
  - Conventional cabling can cause diurnals
    - Lo-tempco cabling is relatively inexpensive
  - Low-tempco GPS antennas exist
    - Ours cost $4,000

Action/Conclusion

- USNO and some BIPM staff have prepared resolution to CCTF, recommending:
  - BIPM to develop carrier phase GNSS
    - Analyze data
    - Reduce data
    - Prepare to use in Circular T
- AIUB funding proposal should be accepted
    - $15 CHF/year for TAI analysis
- USNO continues to support TWSTFT
  - Recognizes the need to keep technique alive in case GPS and Galileo both disappear