Australian Government
Department of Industry, Innovation and Science

National Measurement Institute

An evaluation of low-cost GNSS receivers for GPSCV time-transfer

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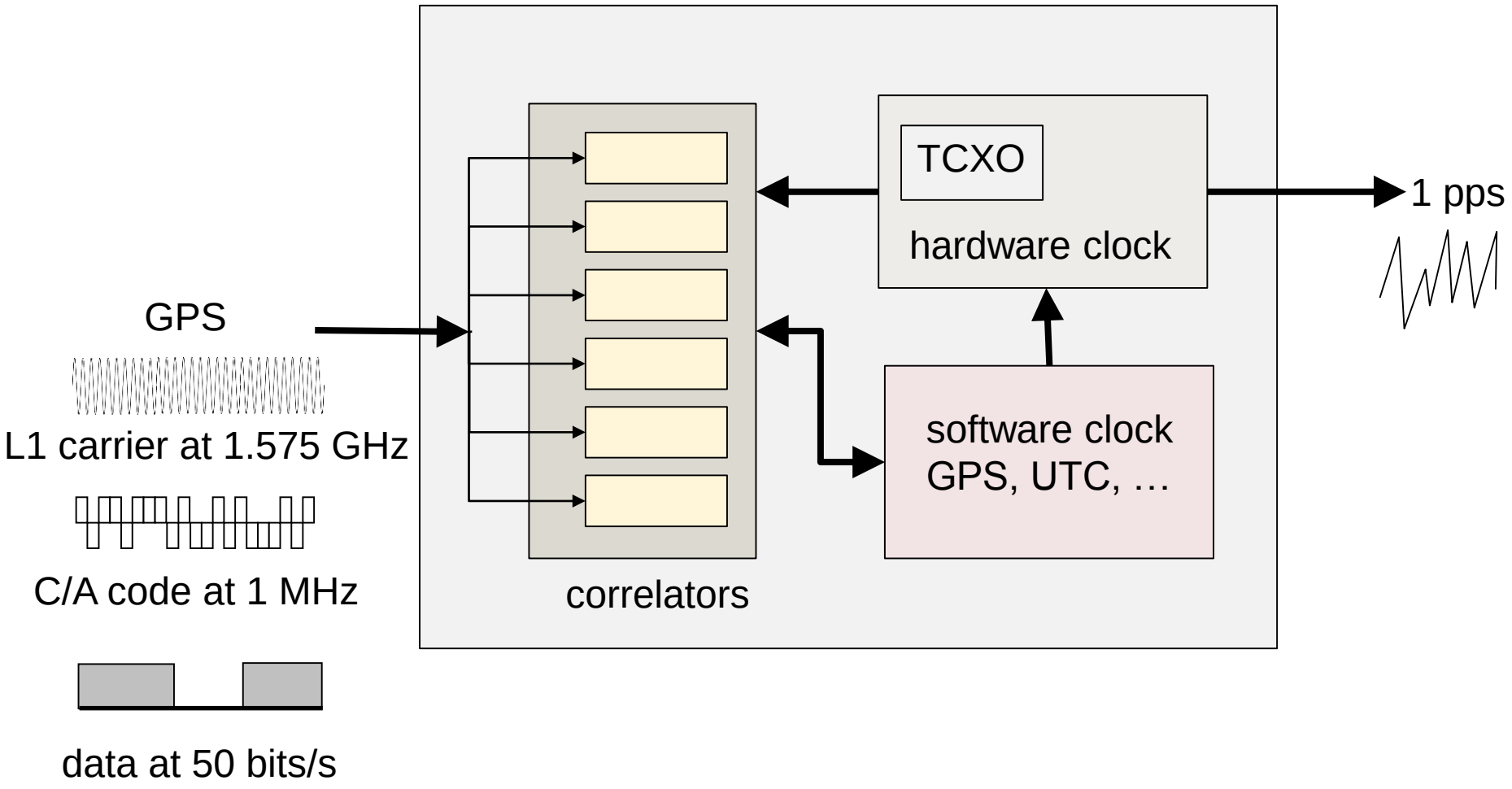
GPS common-view: low-cost receivers

- multi-frequency
- multi-GNSS
- hundreds of channels
- external reference, 1 pps sync
- ~ $15K

- single frequency
- multi-GNSS (but limited combinations)
- tens of channels
- no timing inputs
- < $100

Timing in GNSS receivers



Data required from the receiver

‘Raw’ code measurements – difference between each SV’s clock and the receiver’s reference timescale with no corrections eg ionosphere applied

The time of measurement is critical.

A well-defined relationship between the output 1 pps and the reference time scale is also required.

Optionally:

- broadcast ephemeris for local processing
- sawtooth correction for the 1 pps

Two low-cost receivers: the NV08C and NEO8MT

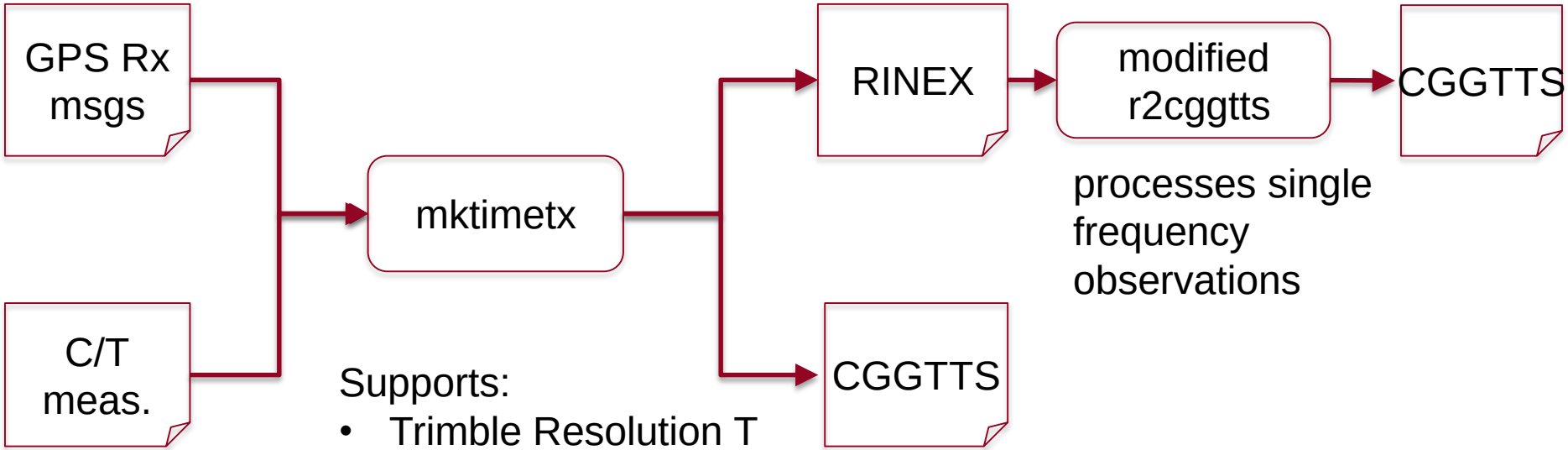
NVS Technologies NV08C

- L1 GPS, GLONASS, Galileo
- 32 channels
- 1 pps accuracy 15 ns
- 2 x RS232 serial ports
- NMEA and proprietary binary format data streams
- code and carrier phase measurements available
- Introduced 2010

ublox NEO8MT

- L1 GPS, GLONASS, BeiDou
- 72 channels
- 1 pps accuracy 20 ns
- 1 x RS232, 1 x USB serial ports
- NMEA and proprietary binary format data streams
- code and carrier phase measurements available
- Introduced 2014

mktimetx – GPSCV processing software



Supports:

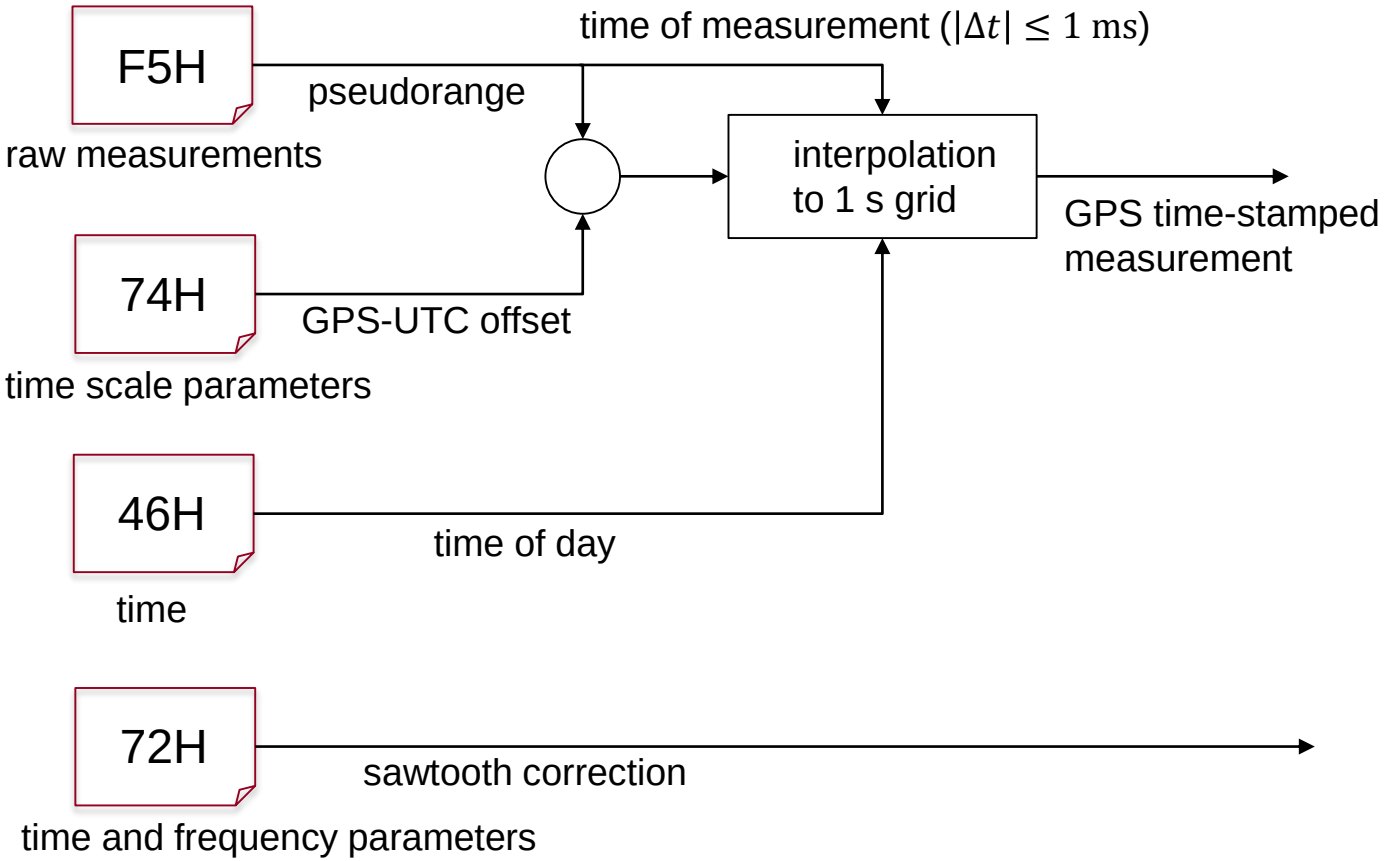
- Trimble Resolution T
- ublox
- Javad (older GRIL)
- NVS NV08C

Software was validated two ways

- comparison with older, independent software for the Javad and Trimble receivers
- comparison with r2cggtts CGGTTS

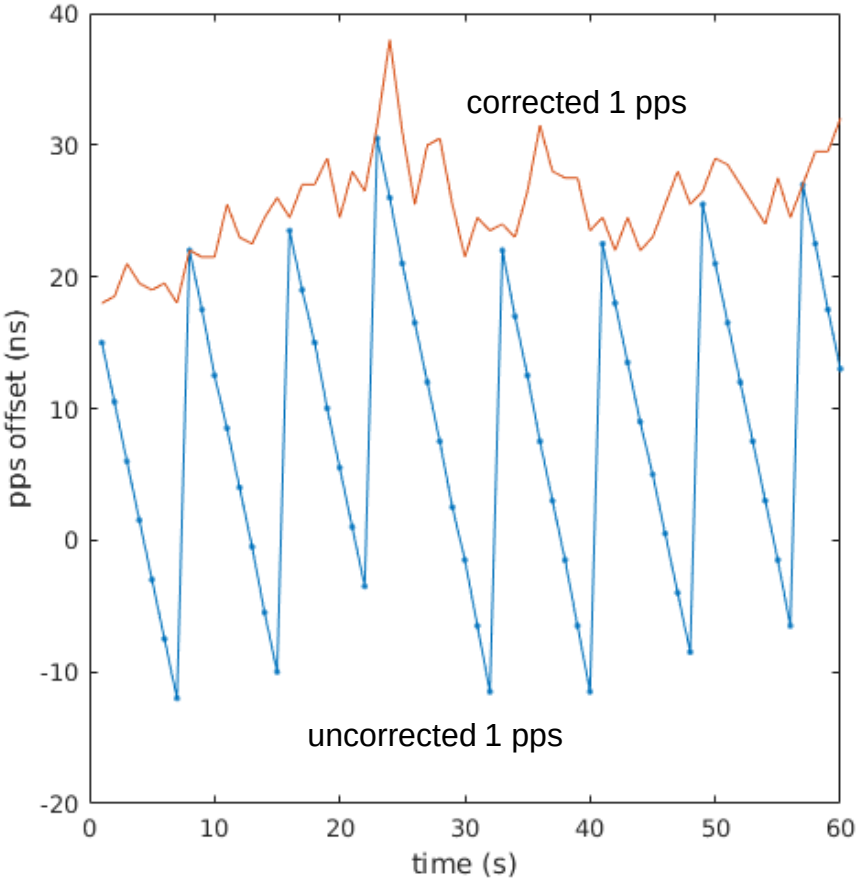
Example: processing of NV08 data

receiver message

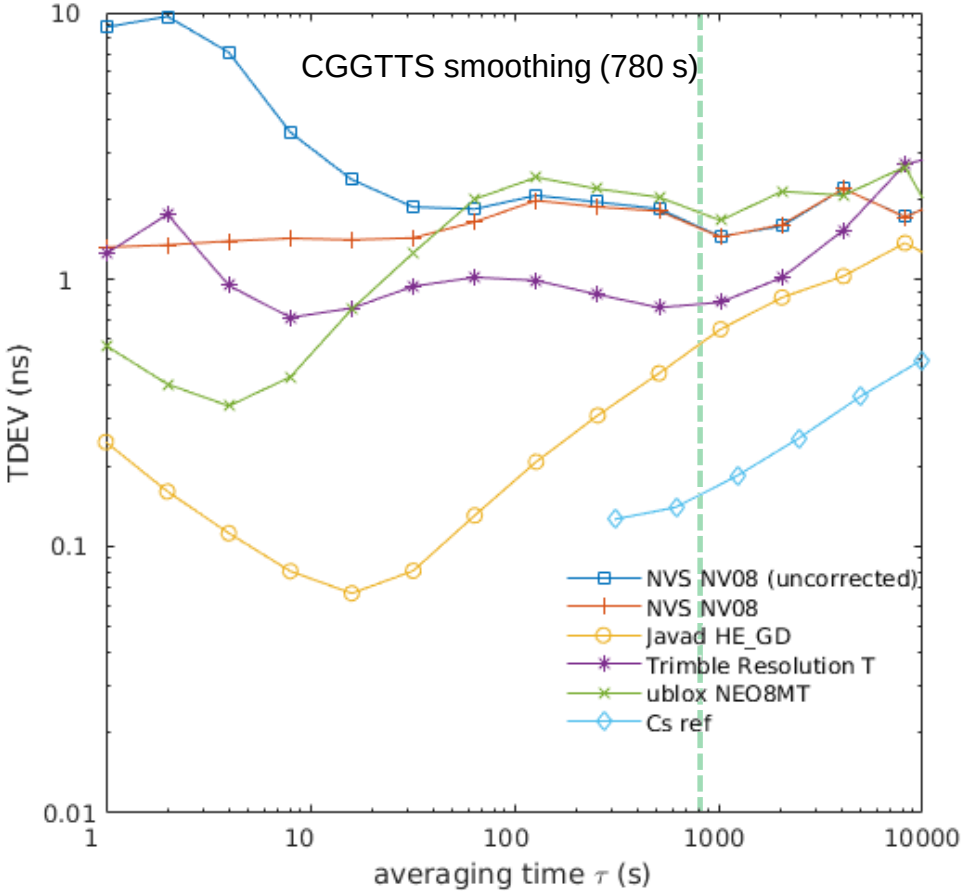


Sawtooth corrections

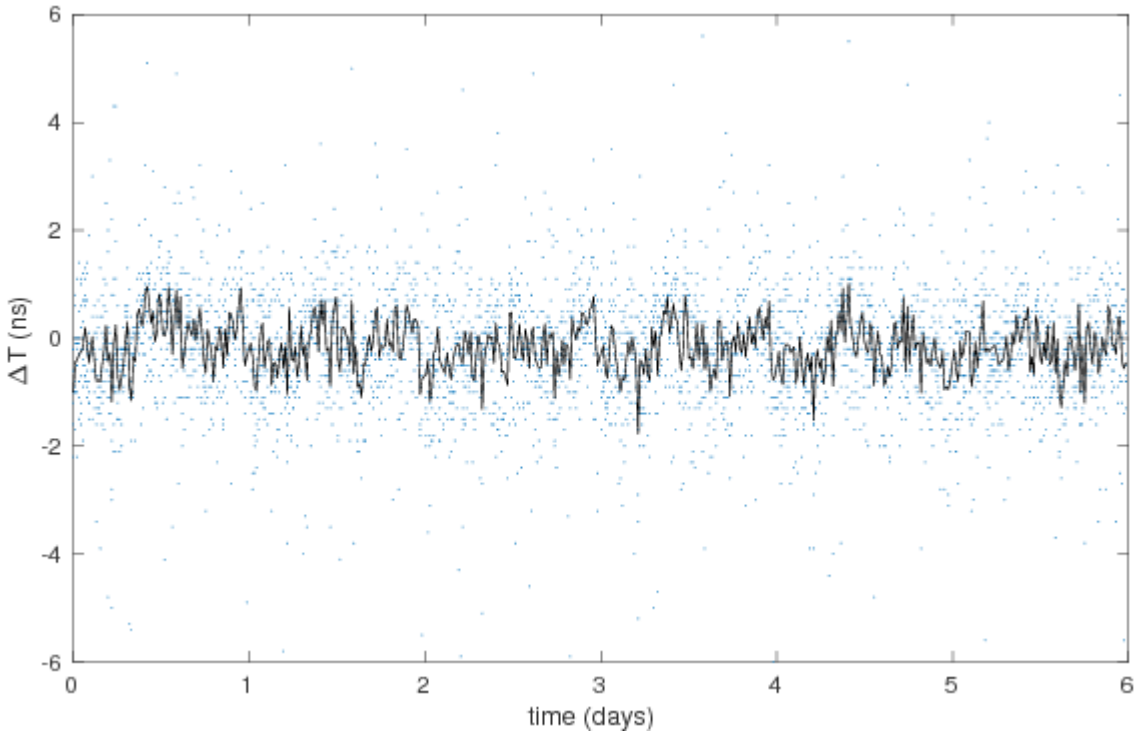
NV08 1 pps



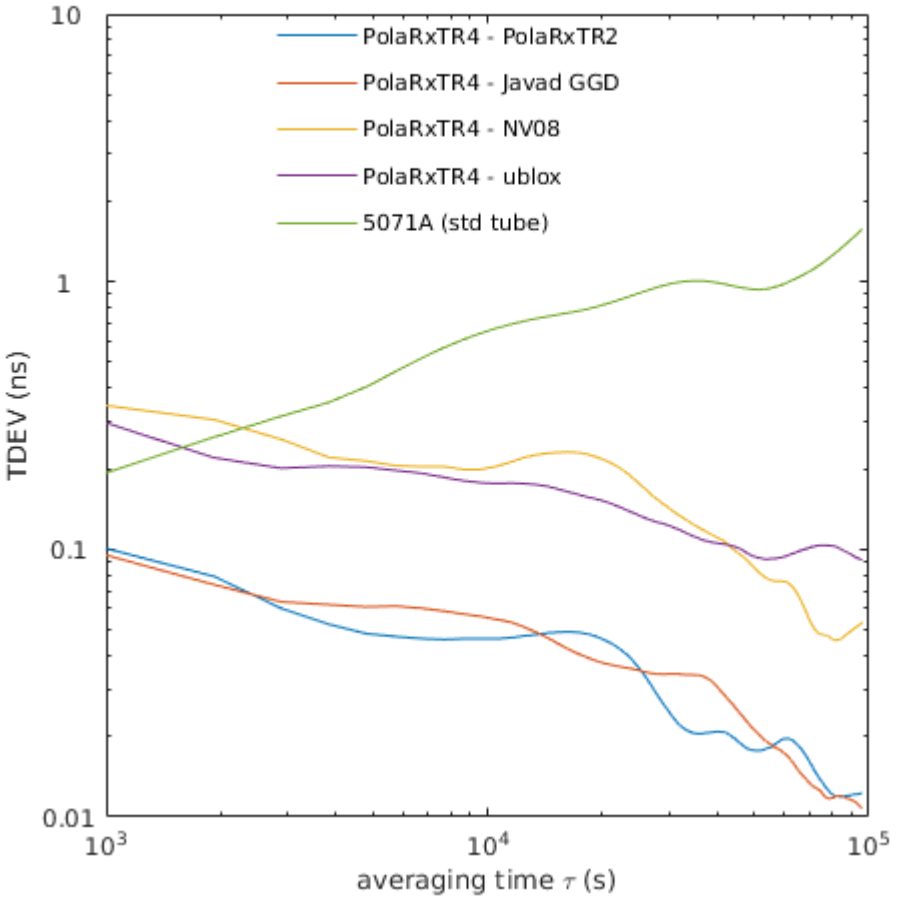
TDEV for various receiver 1 pps' (ref Cs)

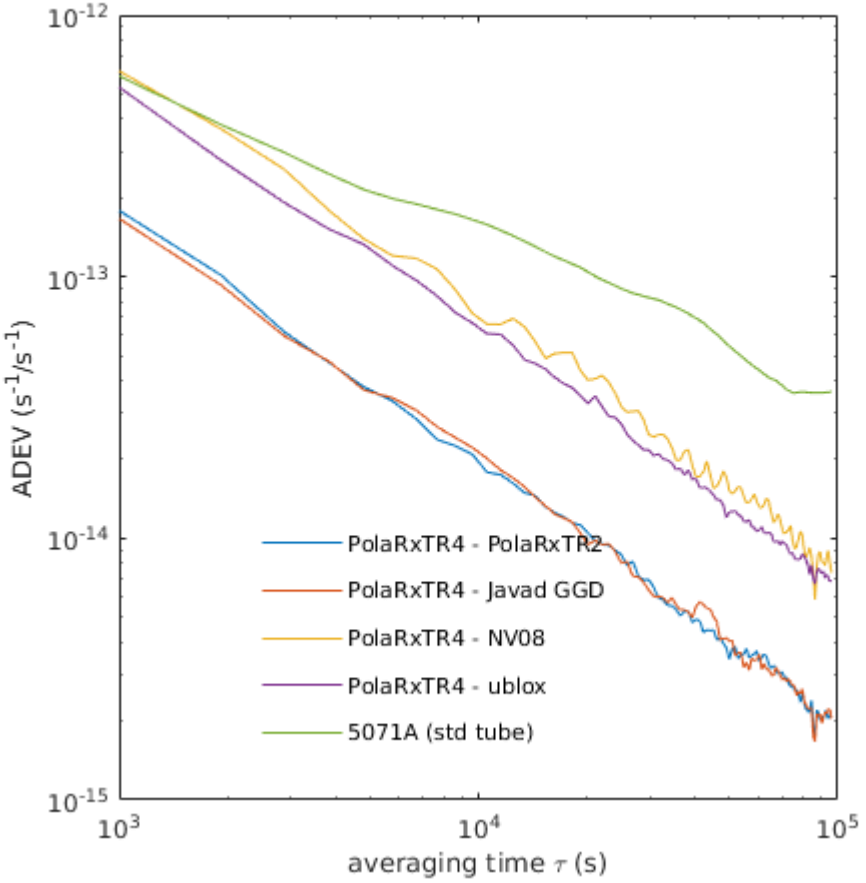


Zero baseline comparison: CGGTTS data



Time-transfer stability: zero baseline comparison of various receivers



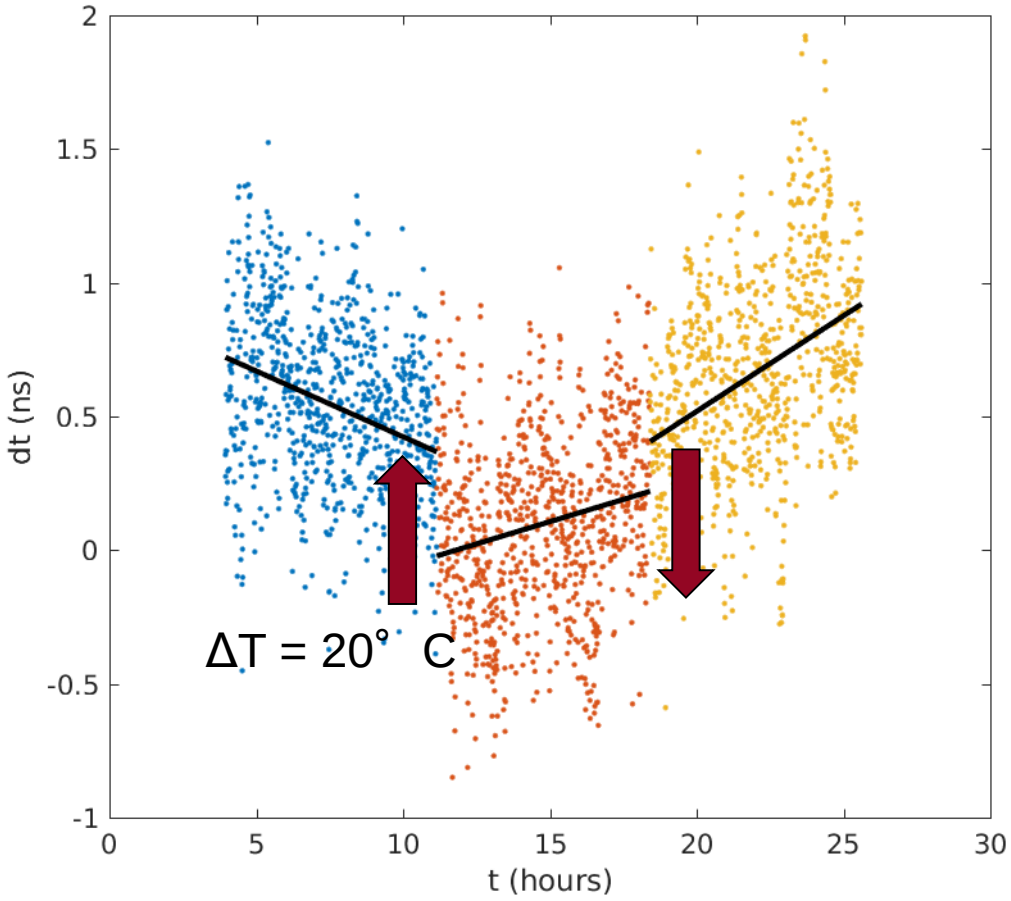


NV08C: internal delay

Unit-to-unit delay variations

firmware	n	C1 delay (ns)
CSM23 02.06	2	166±2
CSM24 04.08	7	170±2

Temperature sensitivity

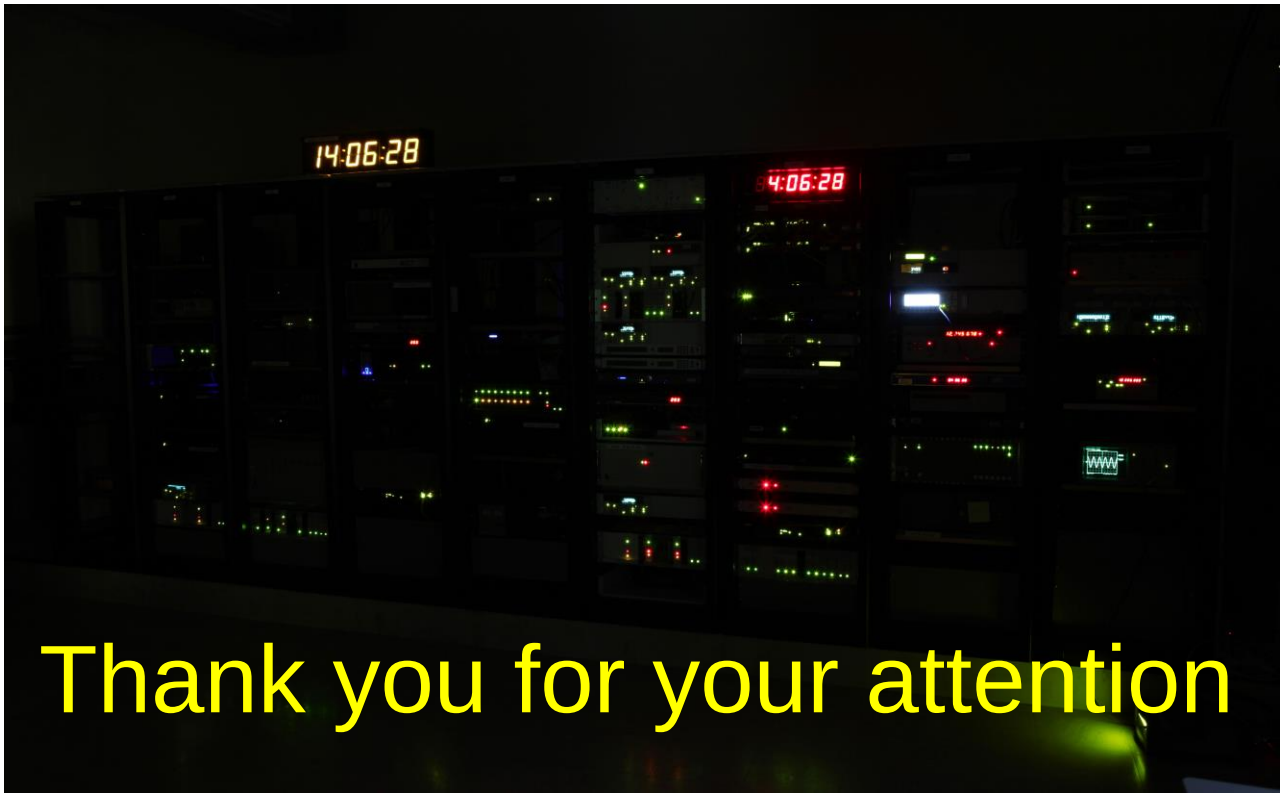


NV08C or NEO8MT?

Ultimately, we chose the NV08C

- conveniently available as an OEM board
- some doubt about whether or not ephemeris messages would be available in future ublox firmware releases

otherwise, little difference performance-wise



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