PPP-RTK & Open Standards Symposium

PPP Ambiguity Resolution Implementation in RTKLIB v 2.4.2
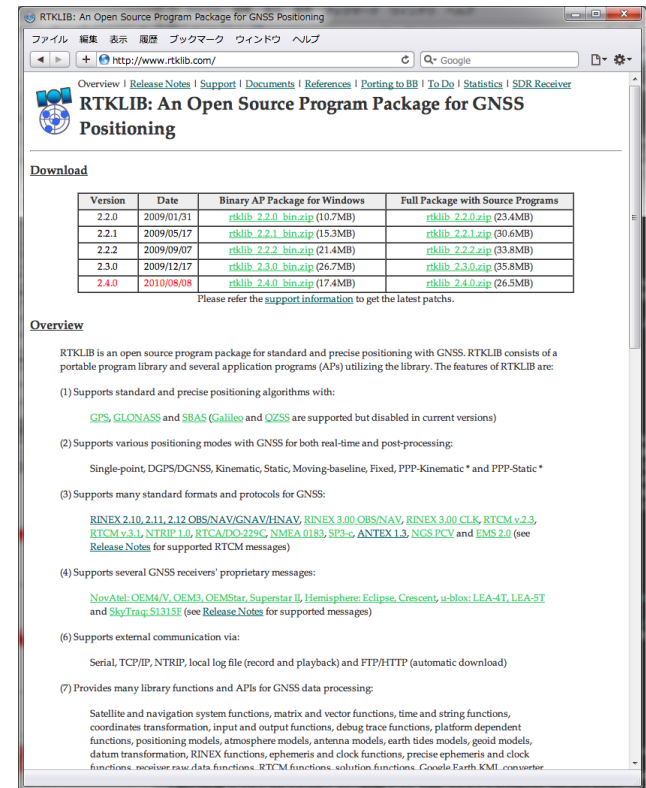
Tokyo Univ. of Marine Science and Technology

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March 12-13, 14, 2012, @Frankfurt am Main, Germany

RTKLIB

- **An Open Source Program Package for GNSS Positioning**
  - Distributed under GPLv3 license
  - Has been developed by the author since 2006
- **Portable Library + Several APs**
  - "All-in-one" package for Windows
  - Potable CUI APs on any environments

http://www.rtklib.com

RTKLIB: Features

- **Standard and precise positioning algorithms with**:
  - GPS, GLONASS, SBAS, QZSS, (Galileo)
- **Positioning mode for real-time and post-processing**:
  - Single, SBAS, DGPS, RTK, Static, Moving-base and PPP
- **Supports many formats/protocols and receivers**:
  - RINEX 2.x/3.0, RTCM v.2/v.3, NTRIP 1.0, NMEA0183, SP3, RINEX CLK, ANTEX, NGS PCV, IONEX, RTCA-DO-229, EMS, …
  - NovAtel, JAVAD, Hemisphere, u-blox, SkyTraq, Furuno, …
- **Supports real-time communication via**:
  - Serial, TCP/IP, NTRIP and file streams

RTKLIB: # of Downloads
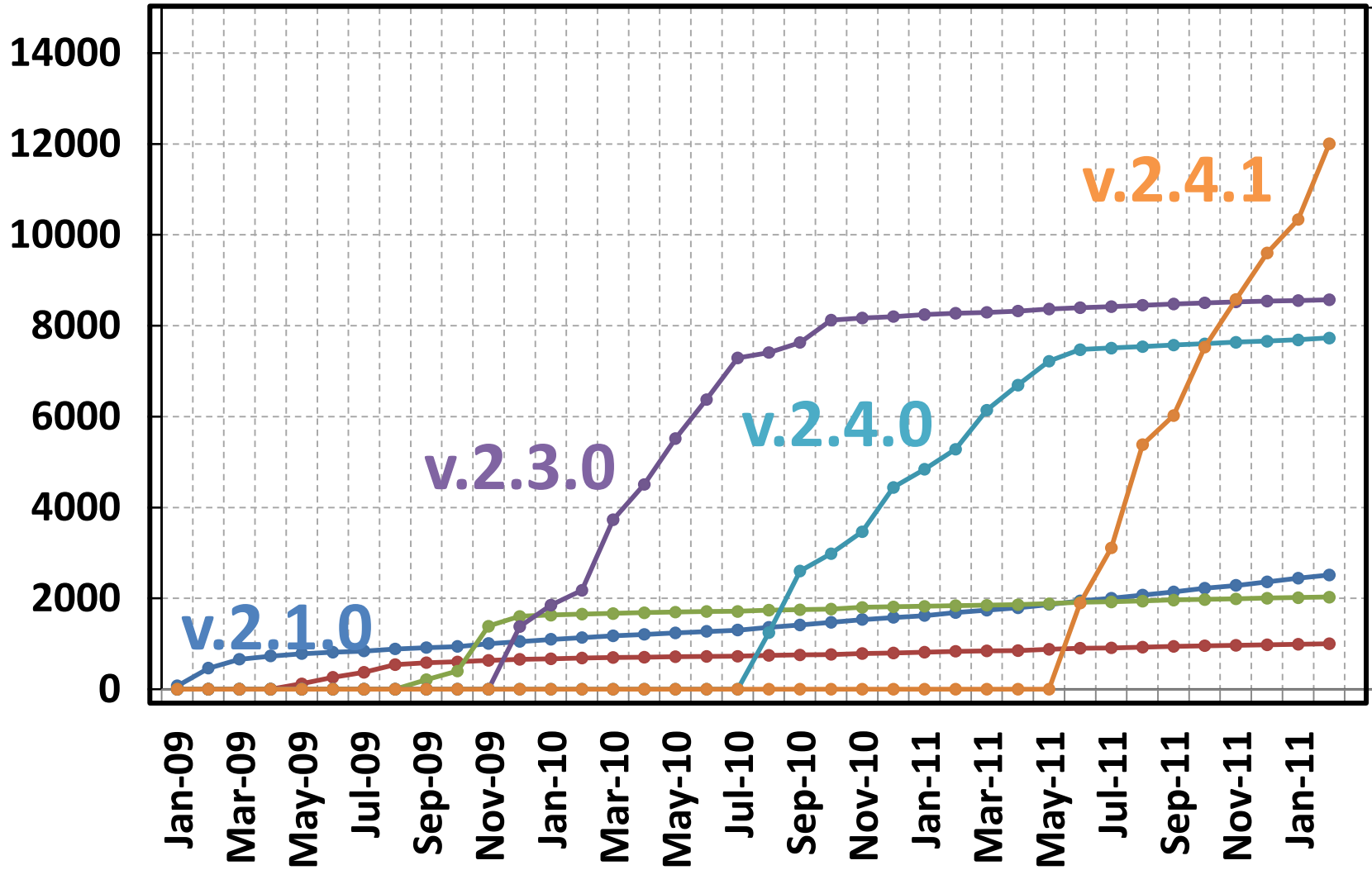
RTKLIB v.2.4.1

- **Released on June 11, 2011**
- **QZSS supported, Galileo enabled**
- **Real-time and post-processing PPP**
  - EPH/CLK: RTCM3 SSR (MT 1057-1068) for RT
  - EPH/CLK: SP3 and RINEX CLK for PP
- **Long-baseline RTK up to 1,000 km**
  - Auto-download of IGU ephemeris
  - Explicit STEC estimation by EKF without LC
  - AR by LAMBDA/MLAMBDA with "partial fixing"

Real-time PPP with RT-IGS

RMS: E: 7.15 cm N: 7.3 cm U: 20.5 cm

2010/12/1 0:00-12/14 23:59 GPST, 1 Hz, RTKLIB v.2.4.0
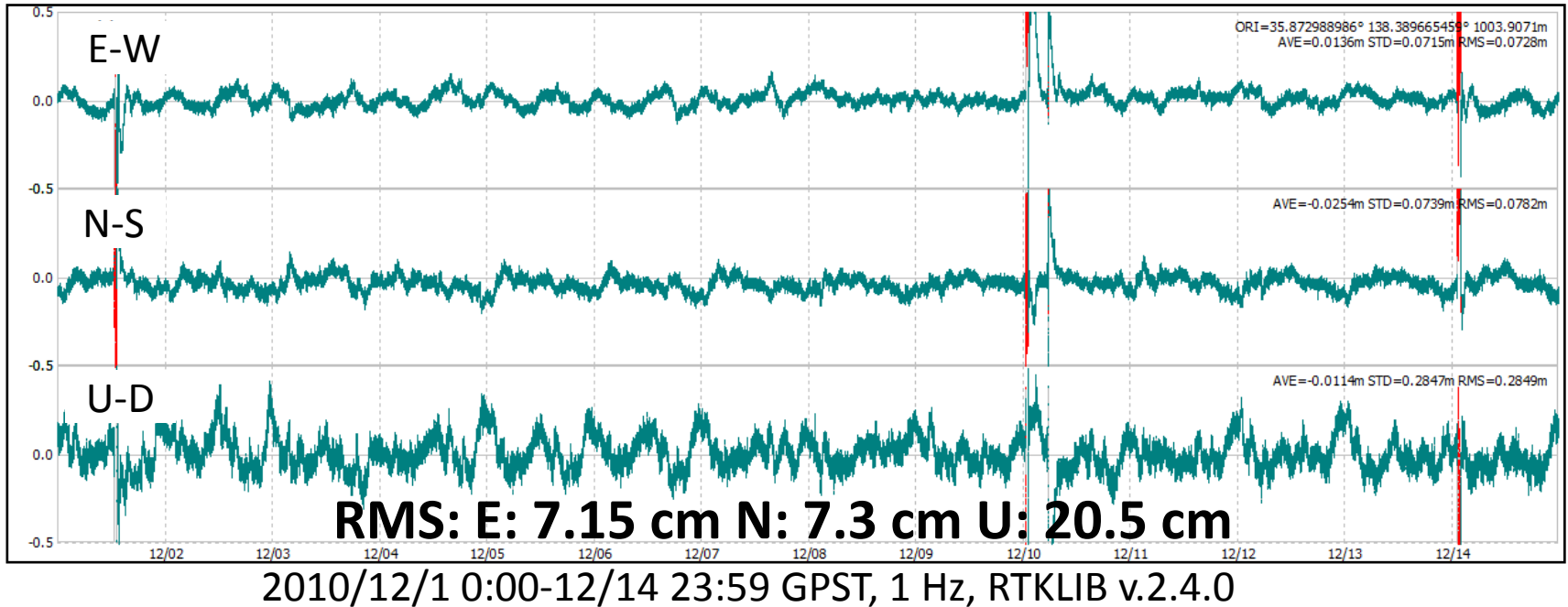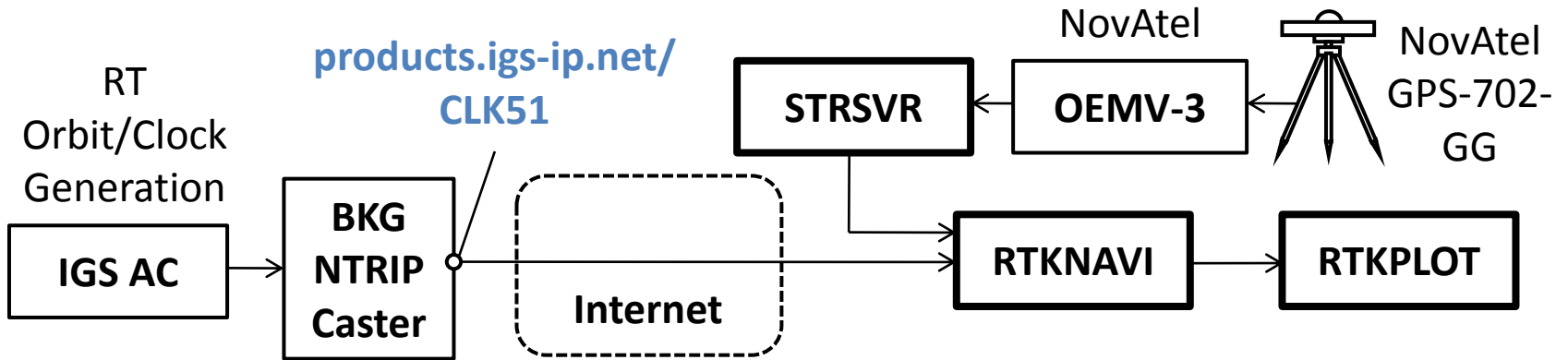
Long-Baseline RTK

2011-3-11 15:45 JST Tohoku-Oki Earthquake (Mw=9.0)
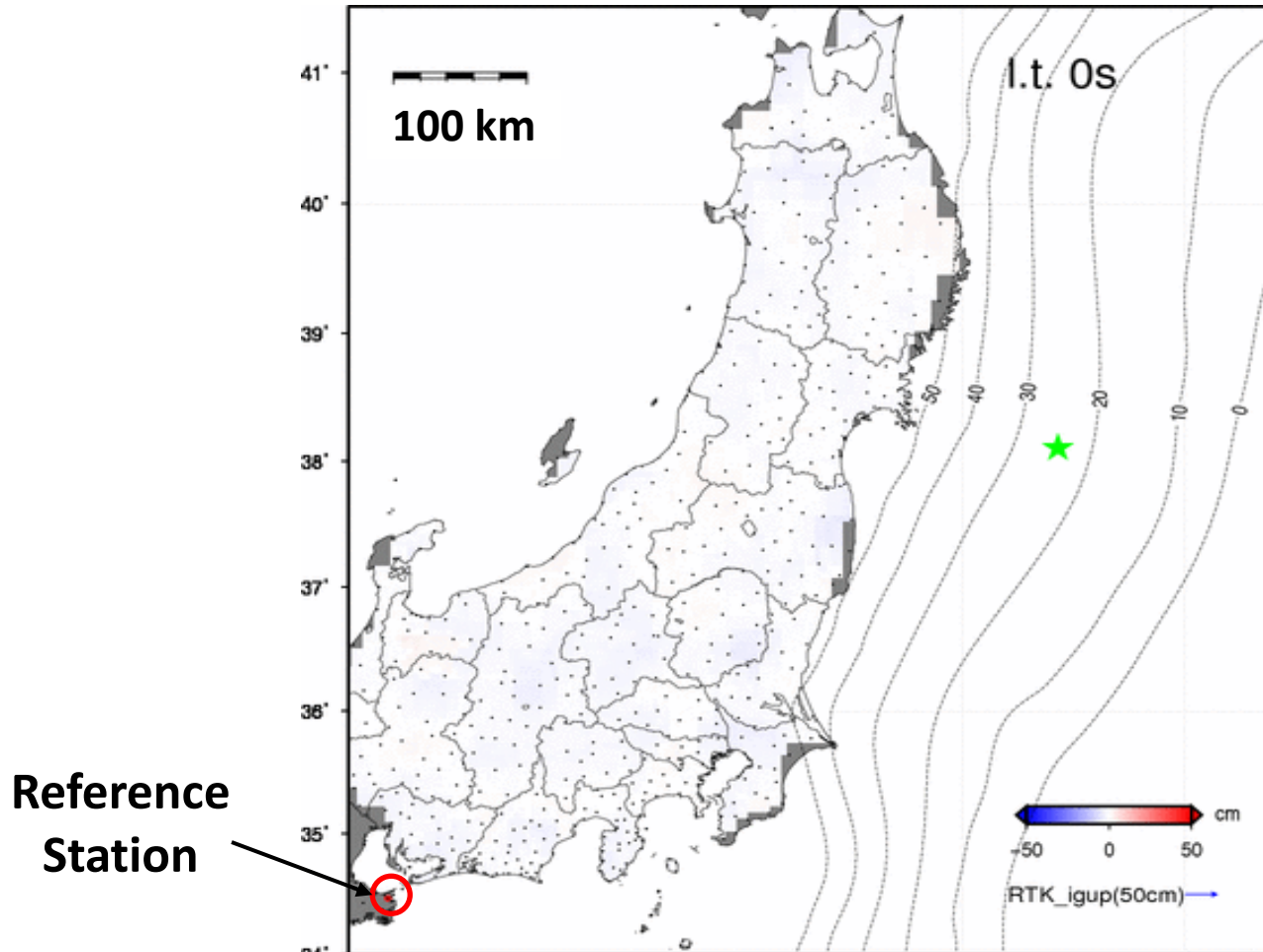
Y.Ohta et al., Quasi real-time fault model estimation for near-field tsunami forecasting base on RTK-GPS analysis: Application to the 2011 Tohoku-Oki earthquake (Mw 9.0), JGR-solid earth, 2012

RTKLIB v.2.4.2

- **Release in summer, 2012**
- **Support of Galileo**
  - RINEX 2 and 3, RTCM 3 ?
  - NovAtel OEM6, JAVAD GREIS
- **RTCM output and conversion**
- **RTCM MSM support (TBD)**
- **PPP model improvement**
- **GUI FTP tool for GNSS products/data**
- **License change: GPLv3 to BSD**

PPP Models in v.2.4.2

	v.2.4.1	v.2.4.2
Satellites	GPS, GLO and QZS	GPS, GLO, QZS and GAL
Troposphere	Standard-Atmosphere NMF + Gradient	GPT NMF or GMF + Gradient
Ionosphere	Iono-Free LC (L1-L2)	Iono-Free LC (L1-L2, L1-L5) or STEC estimation (opt)
Tidal Displacement	Solid Earth Tide: IERS Step 1 + Step 2 K1 radial only	Solid Earth Tide: DEHANTTIDEINEL.F (opt) Ocean Tide Loading: IERS 2010 with BLQ Pole Tide: IERS 2010 with IGS ERP
Ambiguity Resolution	No (FLOAT)	Yes (opt)

PPP-AR in v.2.4.2 (1/2)

- **Several ways depending on ephemeris/clock provider (server-side implementation)**
  - UPD or FCB, phase-clock, decoupled-clock, JPL, …
  - User-side models need highly compatible to server-side: satellite yaw, phase windup, satellite PCV, DCB, …
  - No standard
- **v.2.4.2 only supports phase-clock by CNES**
  - RINEX phase-clock with WL-bias for post-processing
  - RTCM SSR + extension for WL-bias for real-time
  - UPD by GFZ is still under consideration

PPP-AR in v.2.4.2 (2/2)

- **Conventional WL-LC/NL-rounding (implemented)**
  - Slow convergence
  - Validation threshold is sensitive to avoid miss-fix
- **ILS for LC/NL after WL-rounding**
  - Improved convergence (expected)
  - May be "partial-fixing" is necessary
  - Large noise due to iono-free LC
- **STEC estimation and ILS with partial fixing**
  - Basically the same as long-baseline RTK in v.2.4.1
  - Need separated UPD for L1 and L2
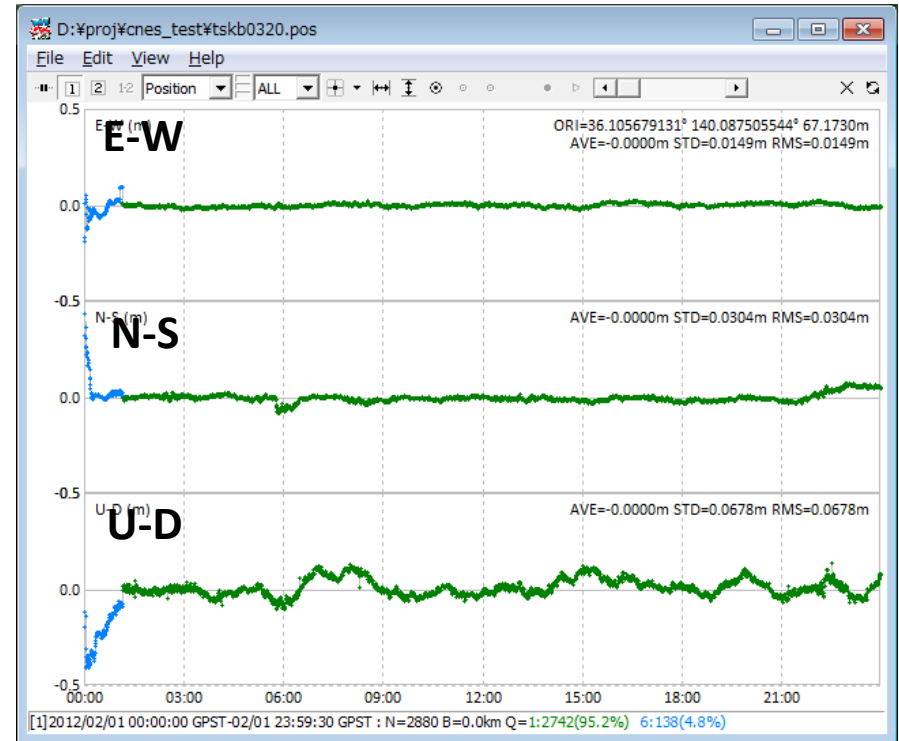
WL-LC/NL-Rounding

FLOAT
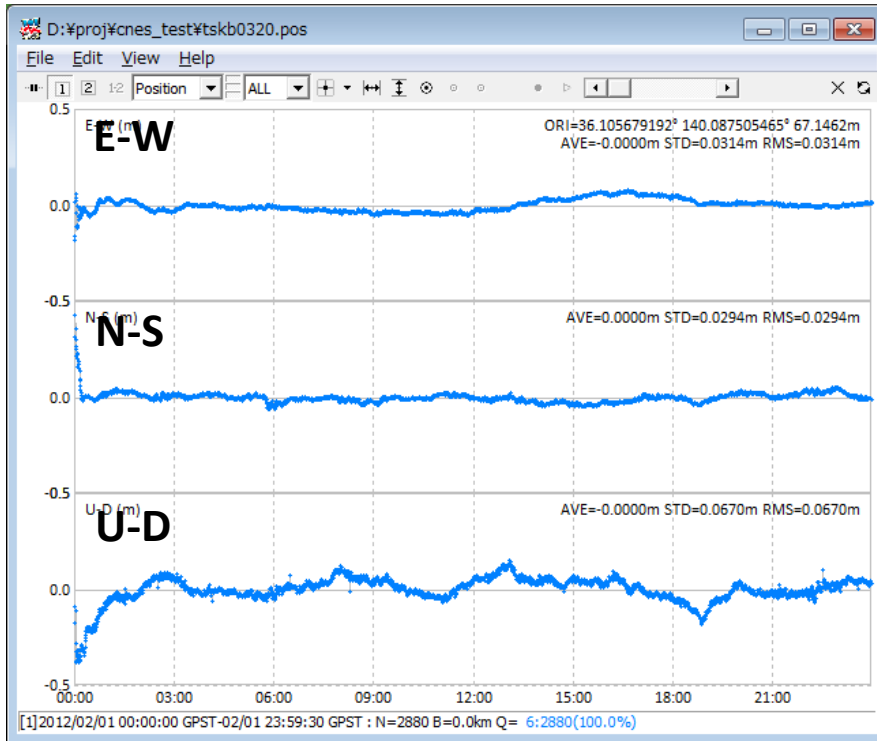
FIXED

RMS E: 3.05, N: 2.16, U: 6.30 cm   RMS E: 1.31 N: 2.09 U: 4.52 cm

IGS TSKB, 2011-2-1 0:00:00-23:59:30 GPST, by RTKPOST 2.4.2 beta
EPH/CLK: C2T16733.SP3 + C2T16733.CLK provided by CNES

JAXA Multi-GNSS PPP Project

- **Precise orbit/clock determination for real-time PPP**
  - GPS, GLONASS, QZSS and Galileo
- **RTKLIB (v.2.5.0?) will be used for PPP-client**
- **First phase for post-processing is finishing**
  - GPS <2 cm, GLO <5 cm, QZS <6 cm (3DRMS)
- **Second phase for real-time will start in April**
  - Latency and CPU power are still issues
  - GLONASS AR with receiver inter-channel bias estimation
- **JAXA requests PPP-AR involved …**

Summary

- **Introduction of RTKLIB**
- **RTKLIB v.2.4.1 Features**
- **RTKLIB v.2.4.2 Features**
- **PPP-AR in v.2.4.2**
- **JAXA Multi-GNSS PPP Project**