



## Abstract

The G-Nut/Anubis QC tool is developed at Geodetic Observatory Pecny (GOP) using core G-Nut software library together with applications for precise point positioning, troposphere monitoring and numerical weather field processing. The G-Nut/Anubis aims at quality and quantity monitoring of GNSS observation and navigation data stored in RINEX 2.x and 3.x formats support of all global navigation satellite systems (GPS, GLONASS, Galileo, BeiDou) and regional augmentations (SBAS and QZSS).

This poster summarizes the purpose, features and current functionalities of the software. Graphical results demonstrate a) single file visualizations, b) multi-station (directory-based) visualizations, c) time-series visualizations.

The G-Nut/Anubis is an open-source tool to deal with a multi-GNSS data collection, dissemination, archiving and analysis to be assured of the data expected quality and content without need of other sophisticated analysis.

The software is regularly tested on full IGS MGEX and EUREF RINEXv3 data archives with focus on monitoring performance of individual GNSS station data collections in time.

## G-Nut/Anubis - main characteristics and functionalities

### Purpose:

- Quantitative analysis
- Qualitative analysis
- Meta data check
- Positioning

### Processing approaches:

- Sequential processing in a single period
- Parallel processing in a single period
- Verbose modes for individual sections

### Availability:

- Current version: 1.1.2
- Next release: 1.2 (Jul/Aug 2014)
- Open-source (GNU GPLv3)
- <http://www.pecny.cz> (GNSS, software)

### Basic characteristics:

- Derived from the G-Nut software library
- Designed for Linux command-line environment
- Developed in C++ (object-oriented)
- Supports all GNSS constellations and augmentations

### Specific algorithms:

- Cycle-slip detection (geometry-free, Melbourne-Wuebbena LC)
- Clock-jump detection and observation synchronization
- Code multipath - all bands/frequencies, constellations, signals

### Inputs/Outputs:

- Configuration: via XML file
- Input: observation and navigation RINEX 2.x/3.x
- Output (detailed): plain text (easy-to-grep, non-redundant)
- Output (summary): XML summary (initial CODE format)

XTR sections: summary, header, estimates, observations, bands, skyplot, code multipath

## Quantitative analysis

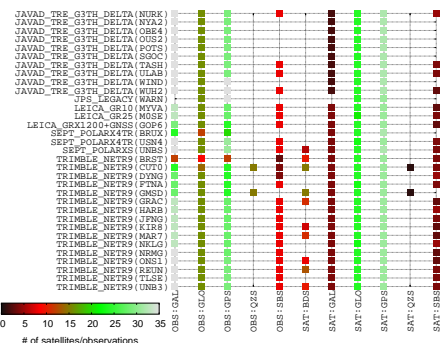
- Independent of specific algorithms, nav. messages
- Statistics on observations, satellites, freq. bands
- Statistics on data gaps and small data pieces
- Comparison of RINEX header and file data content
- Support an easy RINEX content information exchange (feedback to providers), remote file decisions/comparisons (e.g. in GSAC), etc.

## Qualitative analysis

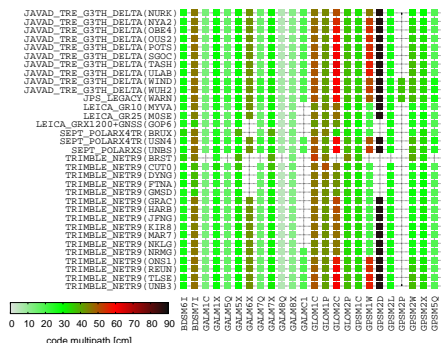
- Requires specific algorithms and navig. messages
- Pre-processing: cycle slip and clock jump detection
- Multipath detection (independent of pre-processing)
- Skyplot: sampled elevation and azimuth
- Support a priori data quality assessment without involved sophisticated analysis tools, usable for data analysts, feedback to data providers

## Standard positioning

- Stand alone single-epoch GNSS standard positioning
- Ver 1.1: GPS + GLONASS
- Ver 1.2: GPS + GLONASS + Galileo + BeiDou
- GNSS means and uncertainties over all epochs
- Multi-GNSS estimates with all biases (near future)
- Observation + SP3 data (near future)
- Pre-selected dual-freq observ. (flexible in future)
- Pre-selected navigation data (flexible in future)



Example of single epoch observation statistics for all files in a directory



Example of single epoch multipath characteristics for all files in a directory

## Meta data control

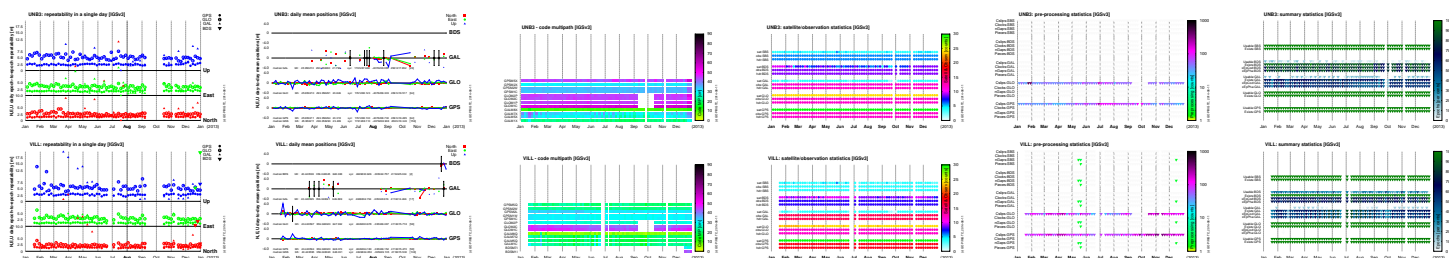
- Foreseen in future (2015)
- RINEX editing/cutting/splicing
- RINEX header control and editing
- External input from station definition file

## QC Navigation messages

- Foreseen in future (still 2014)
- Quality control, editing/cutting/splicing
- GPS manoeuvre detections
- Comparison to SP3 (potential function)

## RINEX 2.xx/3.xx monitoring examples (IGS/M-GEX and EUREF/RNXv3)

Yearly QC graphs monitor evolving long-term performances of the experimental data sets. Figures can be browsed via web-interface <http://www.pecny.cz> (GNSS – data center – multi-GNSS). Individual station extractions are accessible at [http://www.pecny.cz/ftp/LDC/xtr\\_gnss](http://www.pecny.cz/ftp/LDC/xtr_gnss). Figures below show example from the year 2013.



From left to right for: Example yearly graphs for a) epoch-wise position repeatabilities, b) daily mean N,E,U coordinates c) code multipath (tracking signals), d) observation/satellites statistics, e) pre-processing statistics, f) overall summary statistics.

## Summary

The G-Nut/Anubis is ready to support new observations in a multi-GNSS world. The software is written using object oriented approach and is thus flexible for future extensions and enhancements, e.g. data editing/splicing, meta-data control/editing, QC of real-time streams, QC of navigation message, editing/splicing navigation messages, support of precise orbits (SP3) and others. Users interested in the software can download the source code from the <http://www.pecny.cz> (GNSS – software – Anubis) and join the G-Nut mailing list at this website.

## References:

- Vaclavovic P, Dousa J (2014), G-Nut/Anubis - open-source tool for multi-GNSS data monitoring, In: IAG Symposia Series, Springer, Vol. 143 (accepted)
- Vaclavovic P, Dousa J, Gyori G (2013), G-Nut software library - state of development and first results, Acta Geodynamica et Geomaterialia, pp 431-436, Vol. 10, No. 4 (172), doi:10.13168/AGG.2013.0042.

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