TOPCON

Benefits from Multi-System GNSS receivers for professional applications

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TOPCON POSITIONING SYSTEMS

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Meeting on GNSS Interoperability (ICG WG-A)

It's time.

Multi-system GNSS receivers

- - Navigation application;
- - GIS application;
- - Survey application;
- - Machine control application;
- - Agricultural application.

Past and present line of TOPCON GNSS receivers

Hiper

GMS-2

GR-3

Odissey-RS

Legasy

NET-G3

Survey GNSS receivers of Topcon

G3 technology: tracking of GPS/GLONASS (C/A, P L1, P L2, L2C) + GPS L5 + Galileo

GMS-2: L1 GPS/GLONASS receiver for GIS with camera and compass.

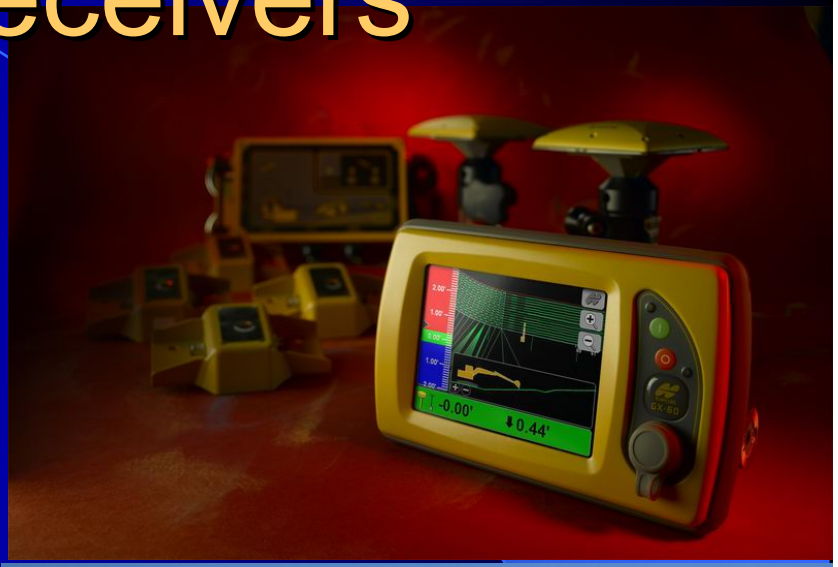
Classical HiPer receivers is very popular receivers.

OEM-boards

- **Euro 112T, 40 channel, GPS/GLONASS L1/L2, 112mm*100mm, 2.7W**
- **Euro 160T, 40 channel, GPS/GLONASS L1/L2, 112mm*100mm, 3.5W, Anti-jamming, input/output frequency, 20nsec PPS, Co-Op tracking**
- **TG-3, 50 channel, GPS/GLONASS L1, 1.2W, 72mm*62mm, 100Hz measurements output**
- **Euro G3 160T, 72 Universal channel, GPS L1/L2/L2C/L5 , GLONASS L1/L2, GALILEO, 160mm*100mm, input/output frequency, 5nsec PPS**

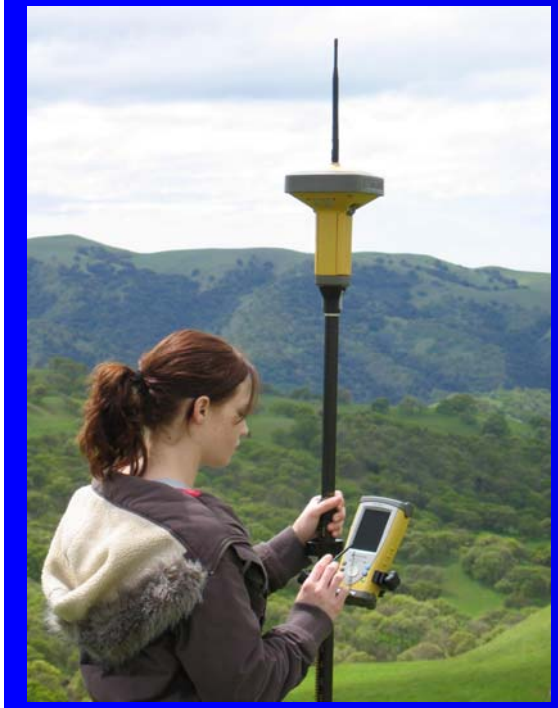
Machine Control of dozers/graders with GNSS receivers

Machine Control of excavators with GNSS receivers



Agriculture with GNSS receivers

Benefits from GPS/GLONASS



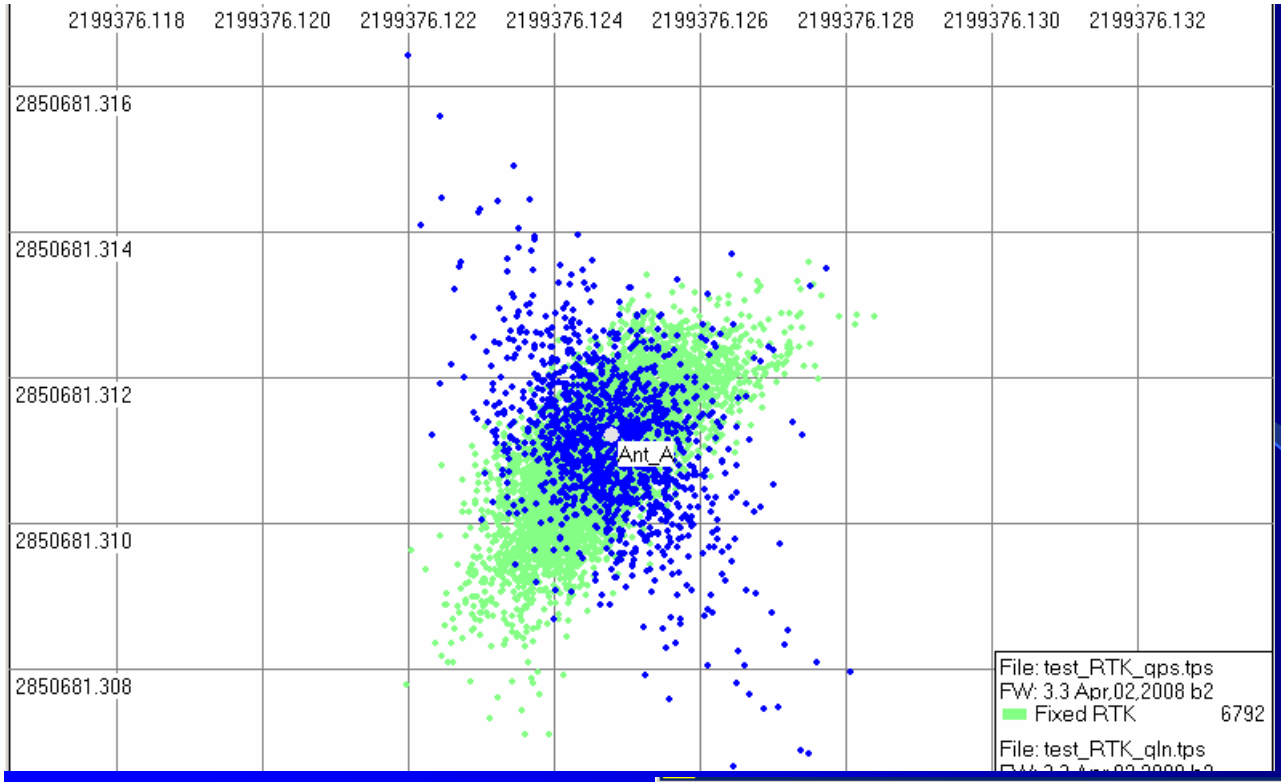
“I've made three big mistakes in my surveying life. The first was getting into a business partnership. The second was not getting 4WD on my truck. The third was not getting GLONASS. If you were in Southern California, I wouldn't be telling you this. Learn from my mistakes... “

From POB message boards

“I have two Legacy receivers and one Hiper, all full GLONASS capable. I can honestly say I can remember only two times in the last 3 years that we had to sit and wait for constellation geometry to come around to get PDOP in the helm of what we demand.

I can also honestly say I've watched two [GPS-only] crews sit on their @$$ for roughly 30-45 minutes at a time, At least once or twice a week. The rodman is pounding on the dirt with his hammer, the crew chief is pounding on the data collector and antenna trying to 'wake it up'. All the while our crews are quietly working away. Some simple math,,,, one hour a week, 52 weeks a year, three years,,, that down time just cost as much as the whole GLONASS capable rover”.

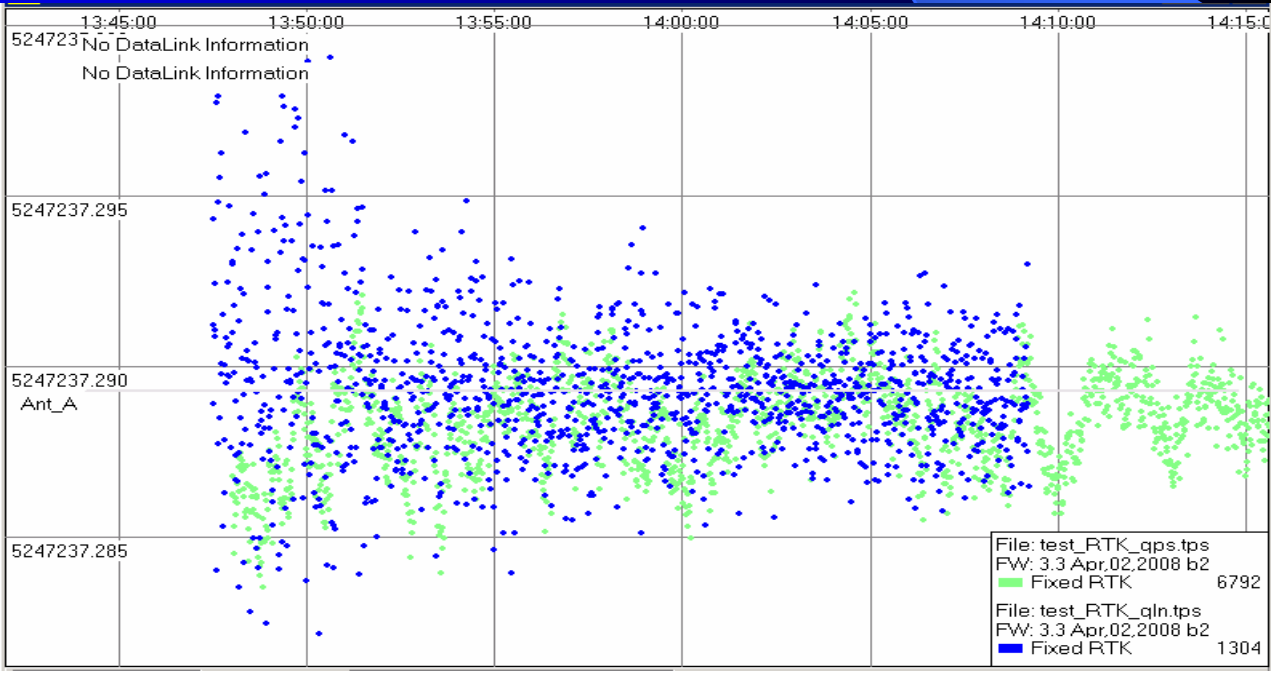
From POB message boards

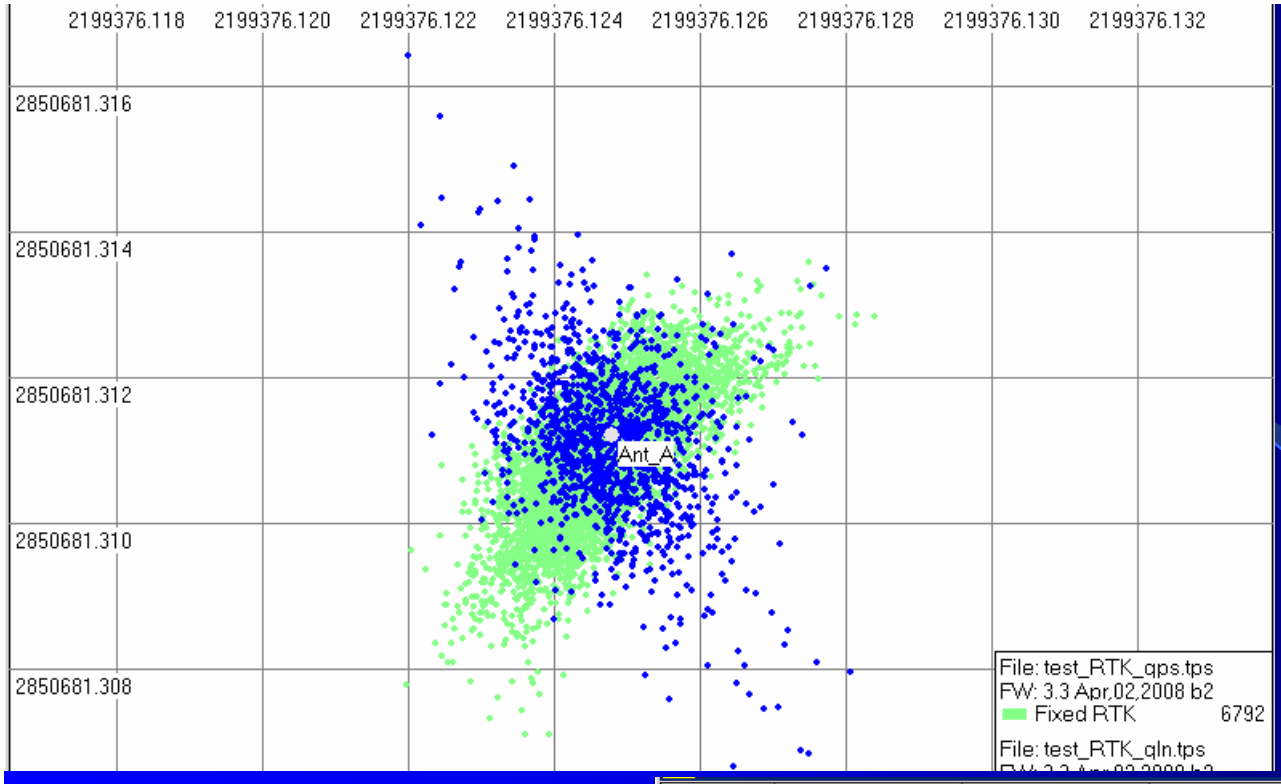


Accuracy of RTK

Green point – RTK with GPS measurement only

Blue point – RTK with GLONASS measurement only





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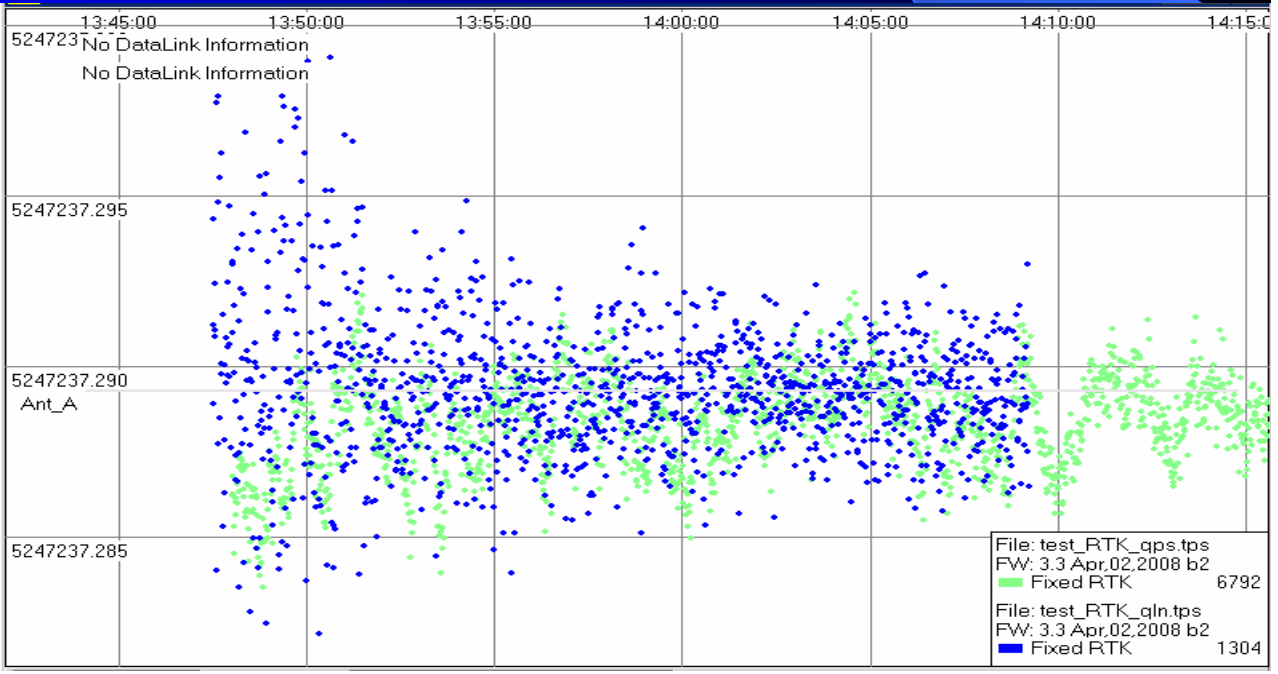
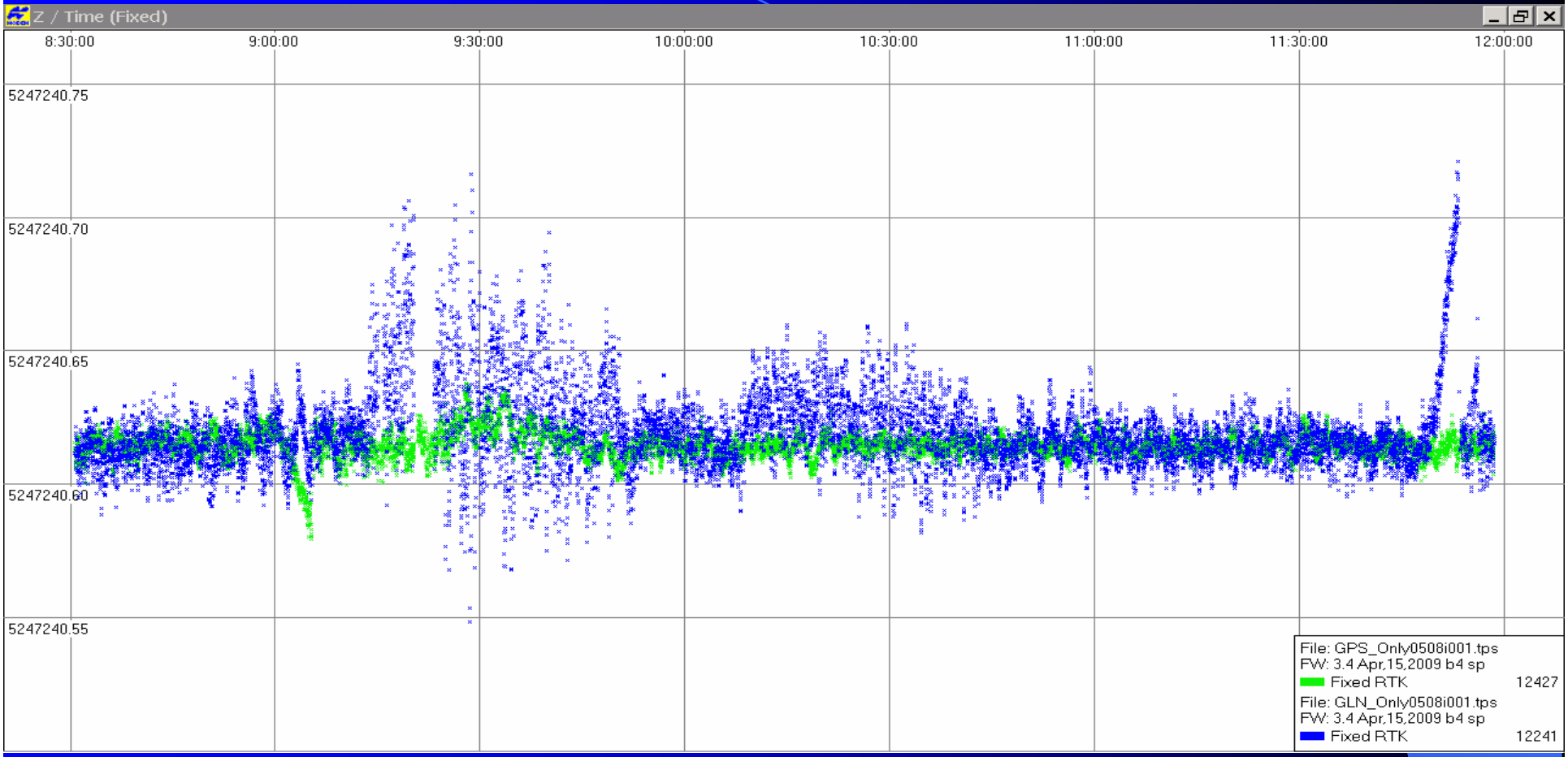


Accuracy of RTK for GPS/GLONASS



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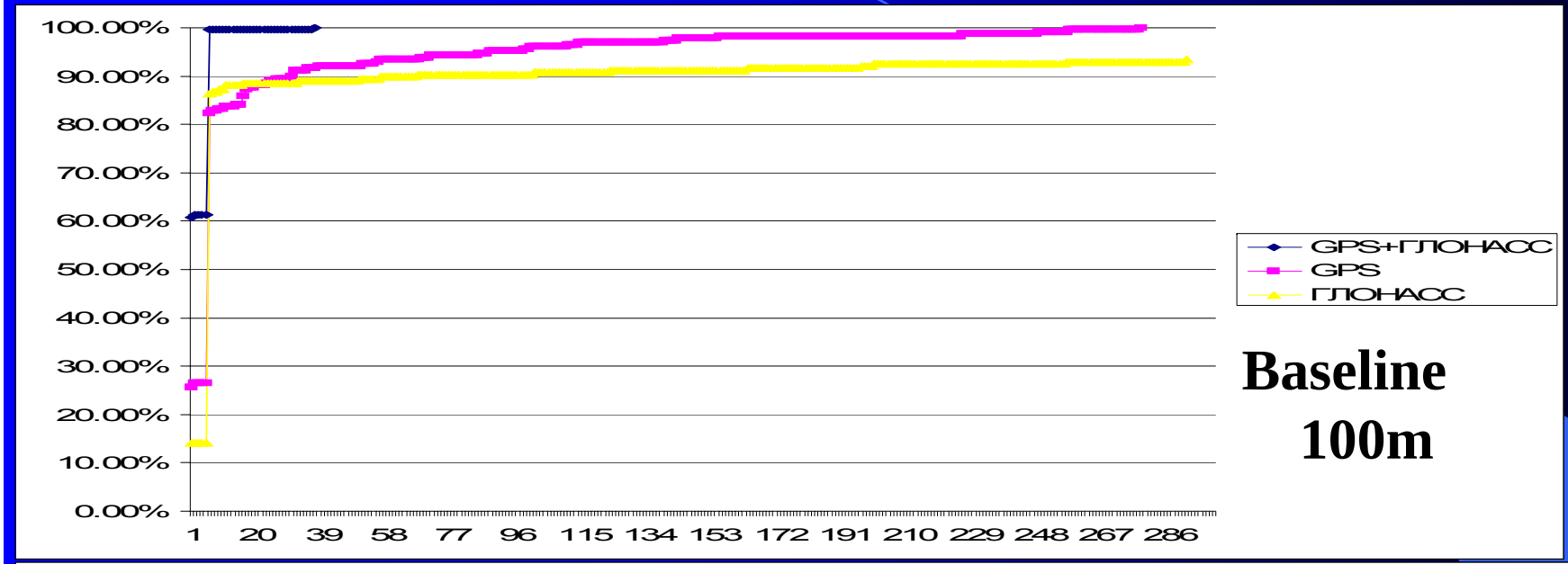
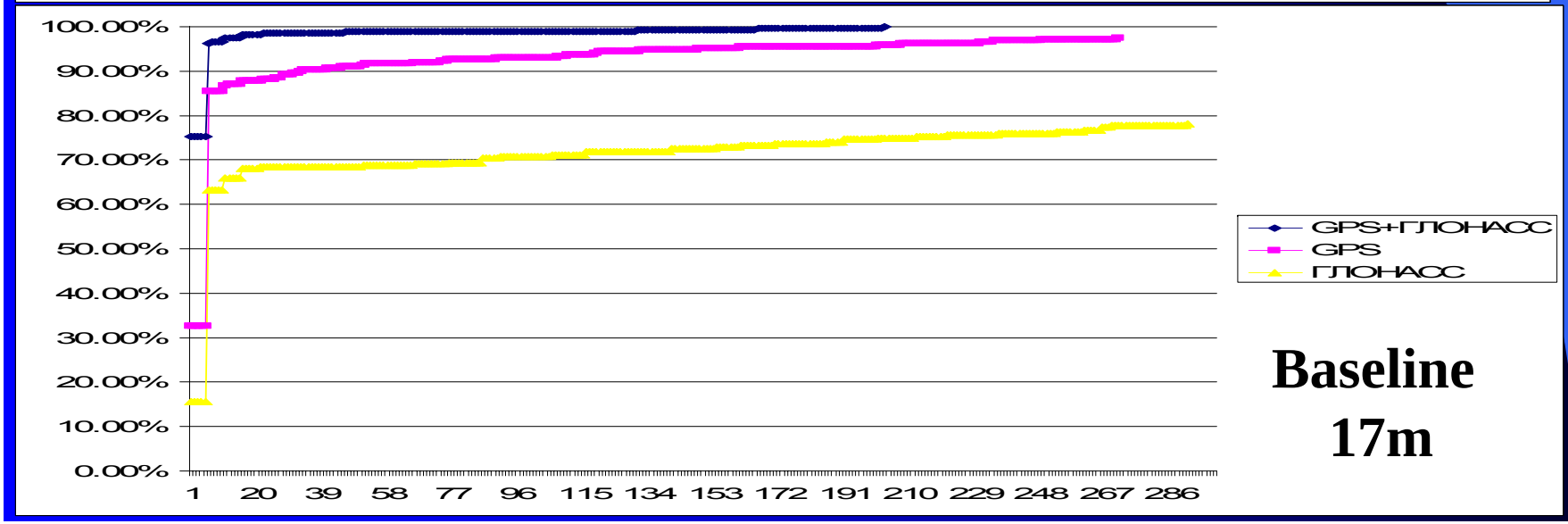
Time-to-fix of ambiguities for RTK with GPS and GLONASS



Baseline 100m



Baseline 17m

Receiver Biases for GLONASS RTK measurements

RECEIVERS	MIN. biases (nearest frequency)	MAX. biases (last frequency)
Ashtech,Javad,Topcon	~ 0	~ 0
Company A	24 mm	144 mm
Company B	7 mm	42 mm

Interoperability issues for different Manufacture

Primary issues:

- Due to variable GLONASS Satellite Frequencies, a GLONASS Observation bias may Be present when comparing data from different manufacturers
  - No bias between Topcon and Ashtech/Magellan
  - Trimble and Leica have GLONASS observation biases compared to Topcon
  - Trimble and Leica have GLONASS observation biases compared to each other

RTCM V3.X

- Topcon has added RTCM3.1 Network Message Support to Rover firmware
- Leica MAC – SpiderNET Network approach is similar to RTCM V3.1 Messages via a Leica proprietary approach similar to RTCM v3.1
- Topcon Rovers successfully handle RTCM V3.1 and MAC

Topcon Use of 3rd Party Reference Receivers Mixed in TopNET Networks

TopNET provides ability to apply GLONASS bias corrections to Trimble and Leica observations in TopNET V8 (Released November 2008)

Gold codes for multipath mitigation

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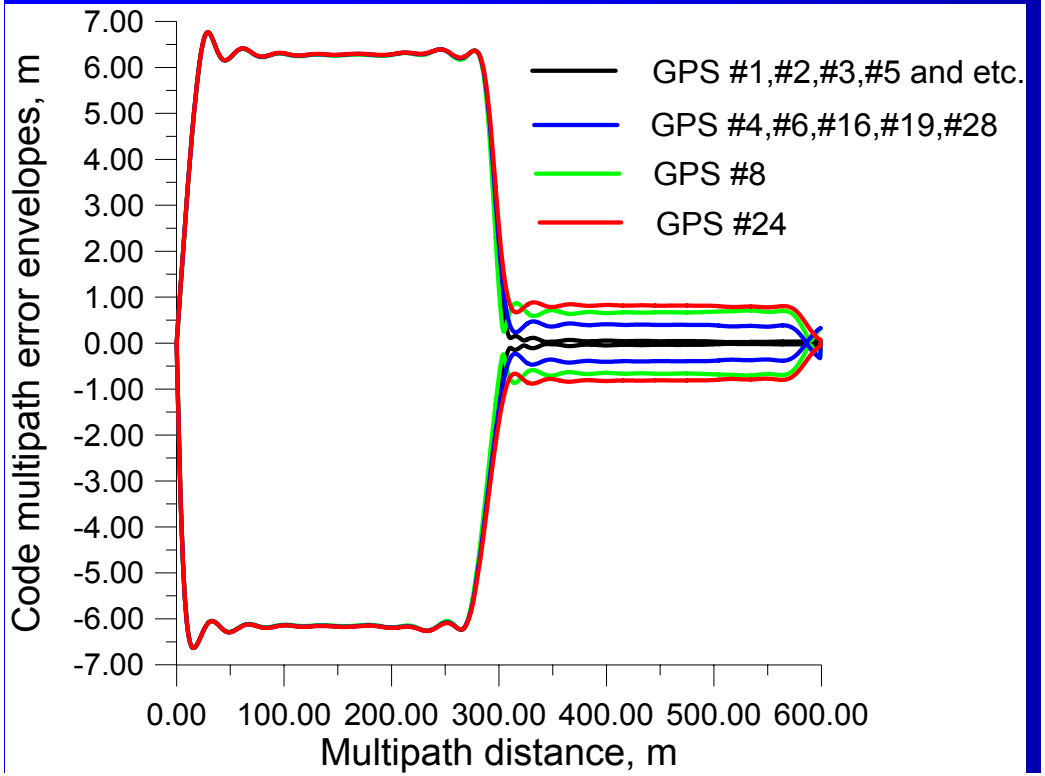
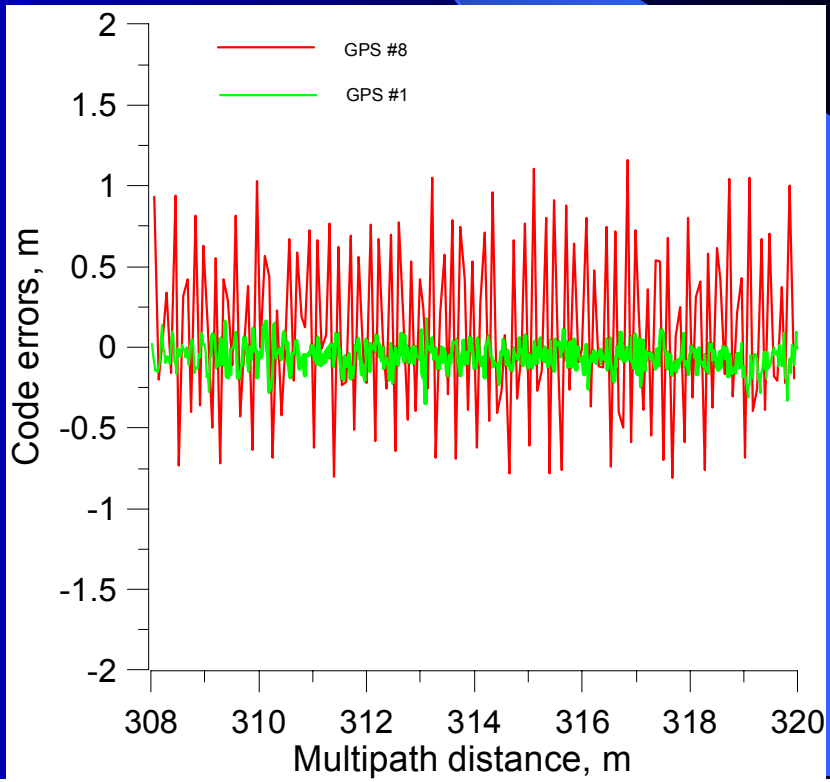
32 Gold codes for L1 C/A of GPS - 14 “irregular” codes for high accuracy measurement and interoperability between different receivers :

#4 , #6 , #7 , #8 , #10 , #15 , #16 , #17 , #18 , #19 , #21 , #22 , #24 , #28



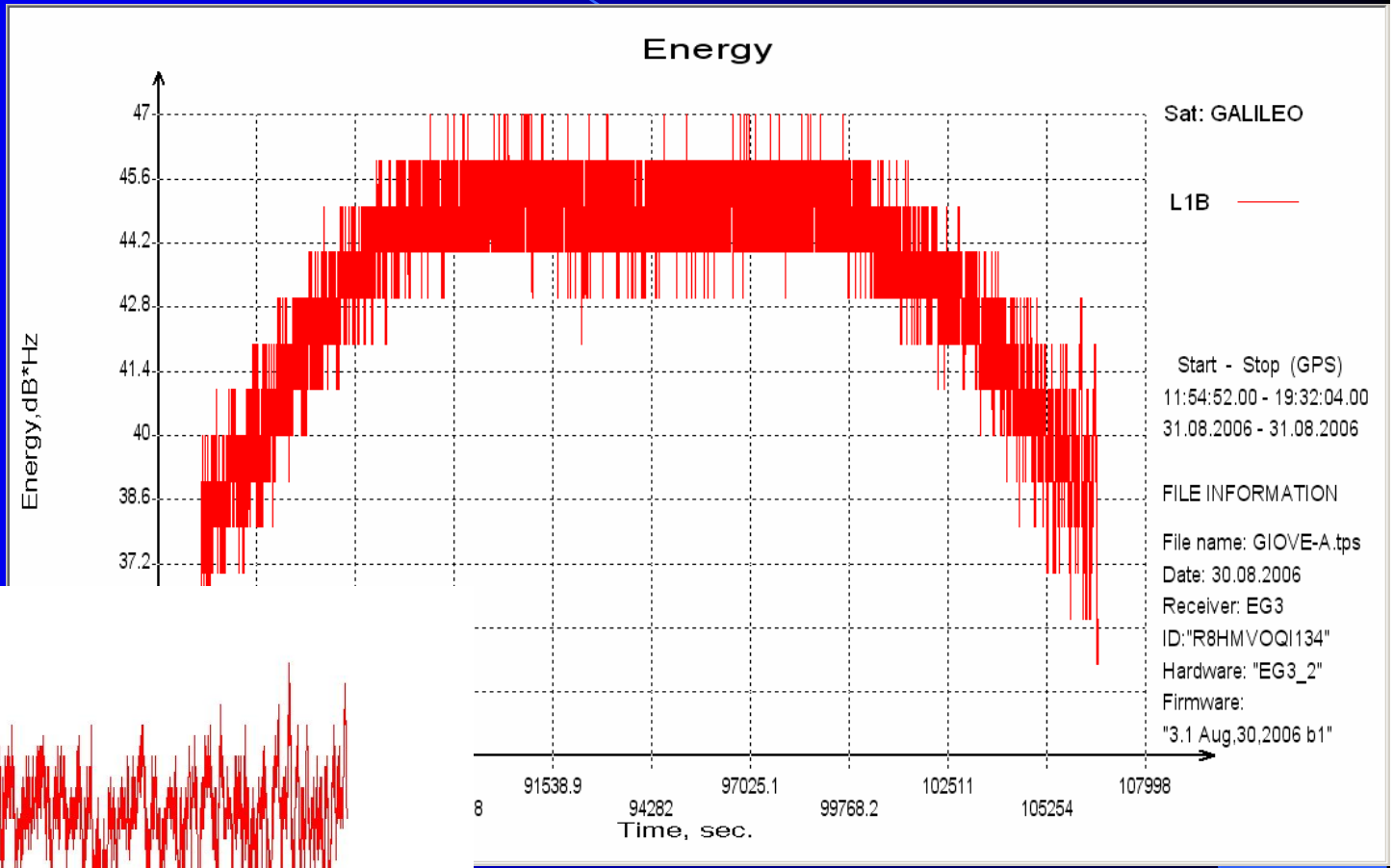


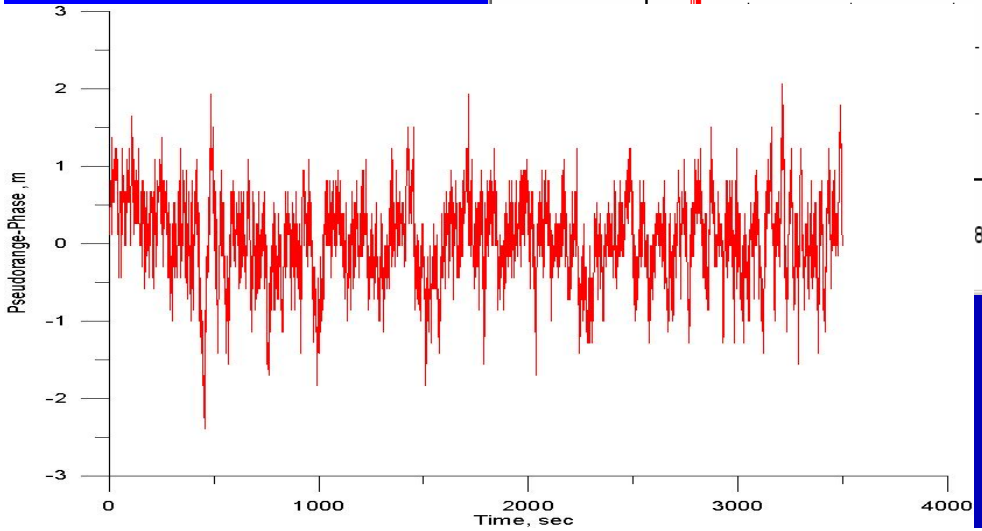
The new Gold codes for other systems

145 new codes from #65 for #210 for different systems–
48 ”irregular” codes:

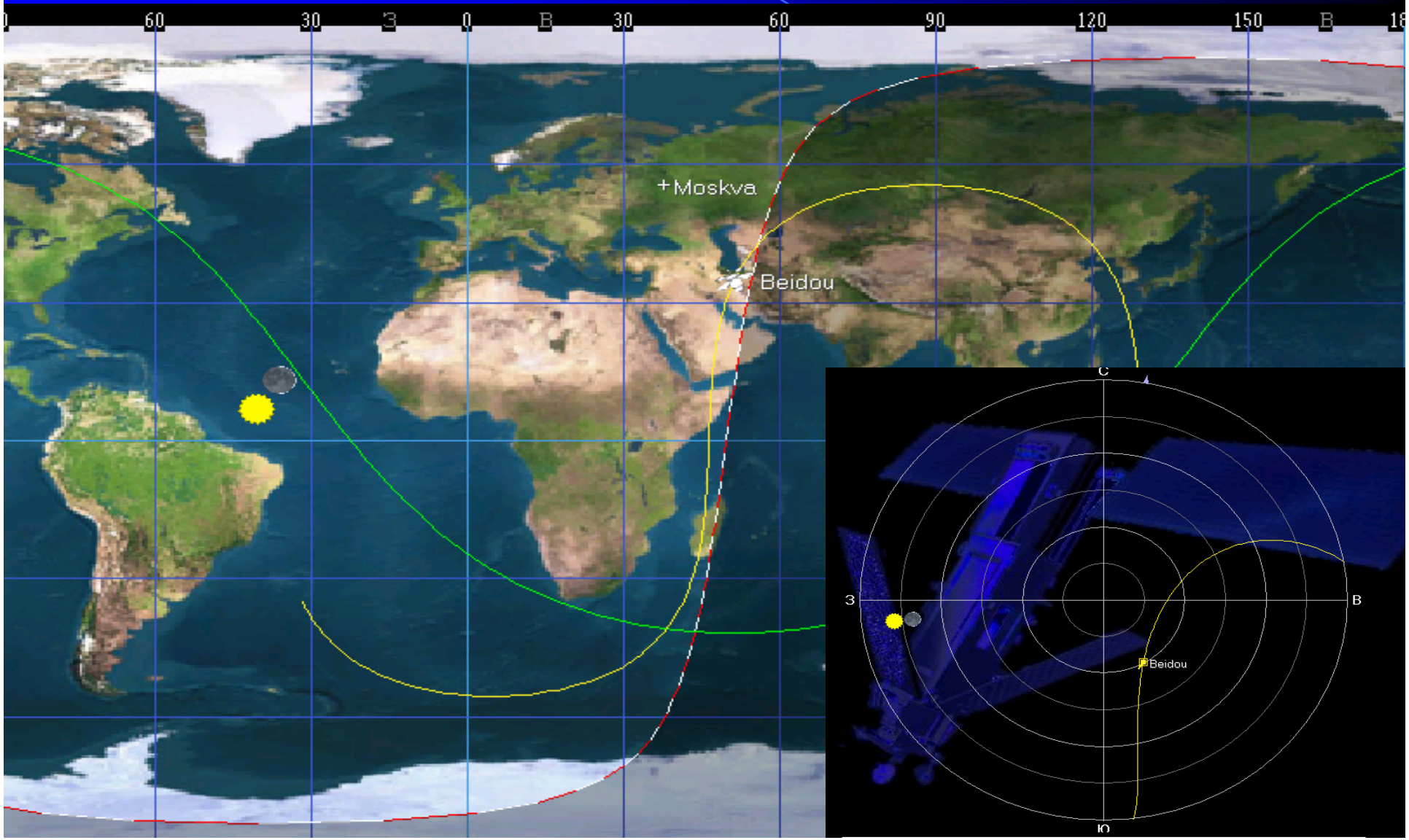
#65, #67, #73, #76, #78, ##81-83, ##92-95, #97, #100, #101, #107, ##112-114, #117, #119, #123, #124, #132, #137, ##147-149, ##167-175, #177, #181, #188, #190, #191, #193, #195, #196, #199, #206, #209

Tracking of GALILEO GIOVE signals





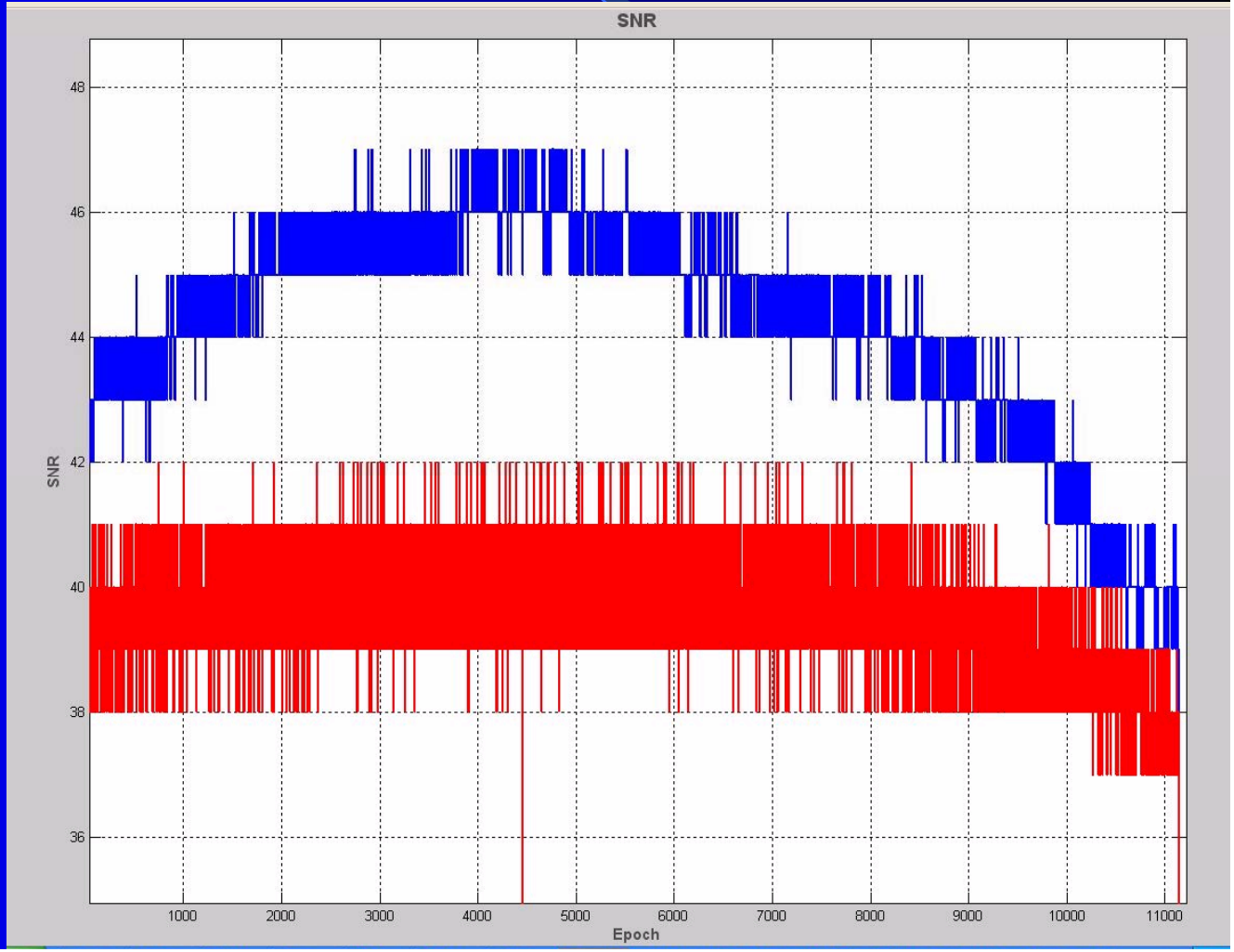
The track of Beidou satellite



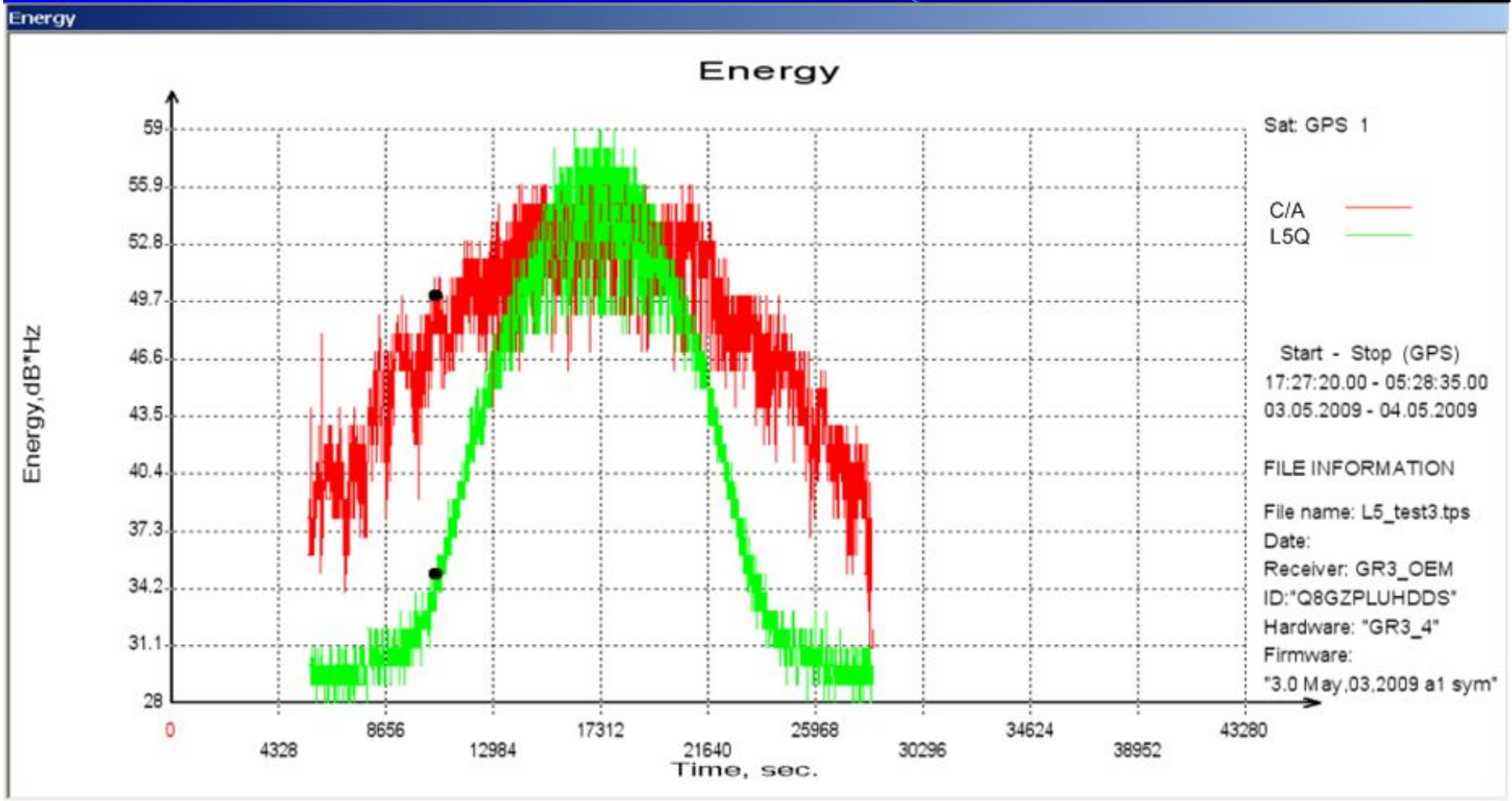
Tracking of signals from Beidou satellite

Blue – energy for B1 signal

Red – energy for B2 signal



Tracking of L5 signal from GPS satellite



Modernization of satellite navigation systems

GLONASS:

The Open Signal in L2 frequency band;
The Open Signal in L3 frequency band (CDMA of FDMA?);
The signals in L1 GPS and L5 GPS frequency bands?

GPS:

The Open Signal in L2 and L5 frequency bands (L2C and L5I, L5Q);
The new Gold codes for L1 C/A;
The Open signal L1C with MBOC modulation of Weil codes (TMBOC is unclean in ICD?).

Future the satellite navigation systems

GALILEO:

The signals in E1, E5a, E5b, E6 frequency bands;
The signals in E5 is unclean in ICD (“memory” codes or not);
The signals in E6 bans is not public (free or not for GNSS receivers company, regulation?)

QZSS:

The signals in GPS frequency band (clean ICD);
The signals in E6 GALILEO band (regulation of information for LEX signal?)

COMPASS:

The signals in E1, E2, E5b, E6 frequency band (is not public ICD?).

GNSS Interoperability for professional applications

- Free signal availability;
- Open access to signals and technical information;
- Improved multipath resistance;
- Improved Jamming resistance;
- Signals in different bands for improved TTF;
- Cross correlation improvements;
- Signals with robust codes and modulation for different receiver technology;
- The faster information about satellite health for all system (transmitting this information from all SBAS satellite)

G3 Technology

The next generation in satellite positioning technology

Thank you for you attention!

Andrey Veitsel

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