EFTF 2012

Smartphone application for the near-real time synchronization and monitoring of clocks through a network of GNSS receivers

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SESSION C3L-B: GNSS AND APPLICATIONS

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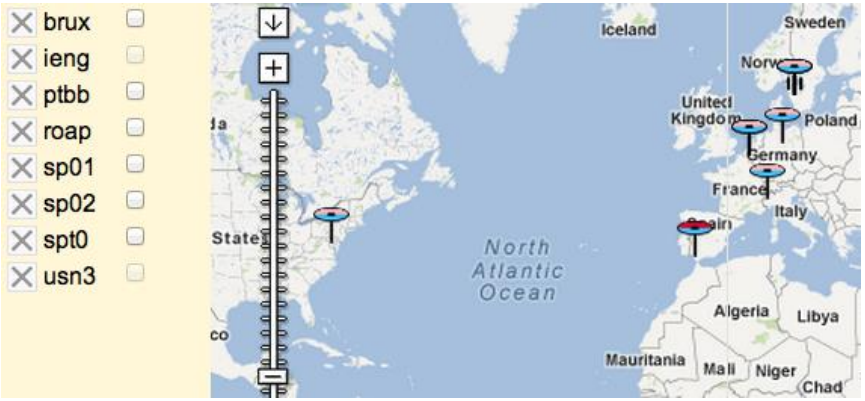
gmv INNOVATING SOLUTIONS

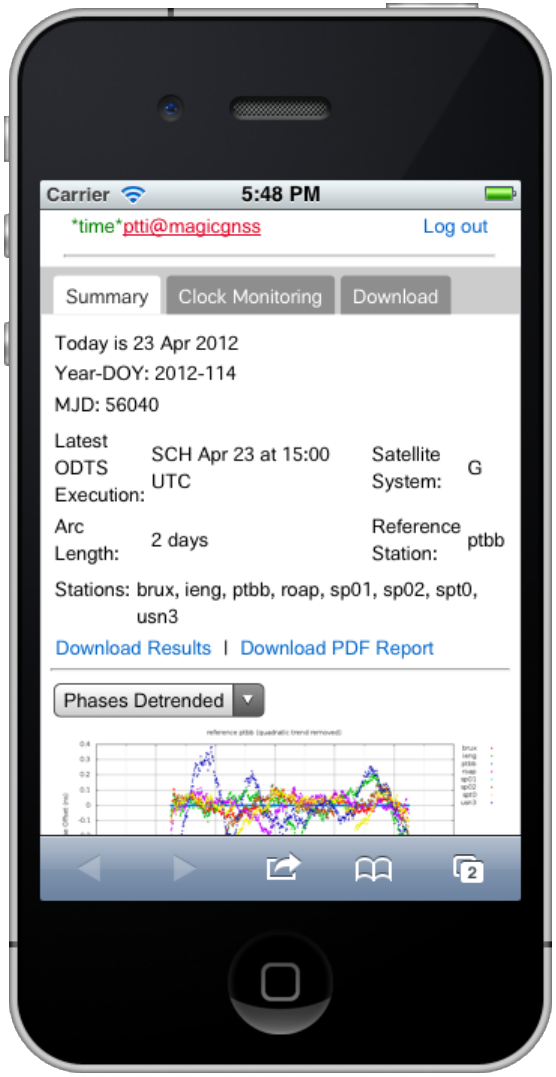
OUTLINE

- Objectives
- Overview of ODTS
- Advantages of ODTS vs PPP
- The *magicGNSS* web-based system
- The Timing account
- The Timing web and smartphone app
- Conclusions

OBJECTIVES

- To synchronize and monitor clocks collocated at different Timing laboratories and connected to a geodetic GNSS receiver+antenna ("station")
- To do it in near-real time, based on hourly RINEX measurement files coming from the participating labs exclusively (via ftp)
- Using a *network solution*: the ODTS algorithm (*Orbit Determination & Time Synchronization*); this is **not** PPP: no precise satellite orbit+clocks *products* are required, just the GPS station measurements
- To automate the process and show the results in near-real time via web and smartphone, in a friendly and robust way
- Participating labs and stations:
  - INRiM (ieng)
  - ORB (brux)
  - PTB (ptbb)
  - ROA (roap)
  - USNO (usn3)
  - SP (sp01, sp02, spt0)

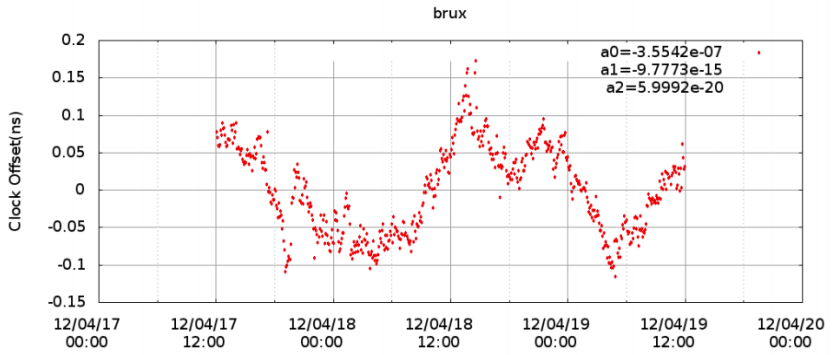




WHAT IS ODTS (1)

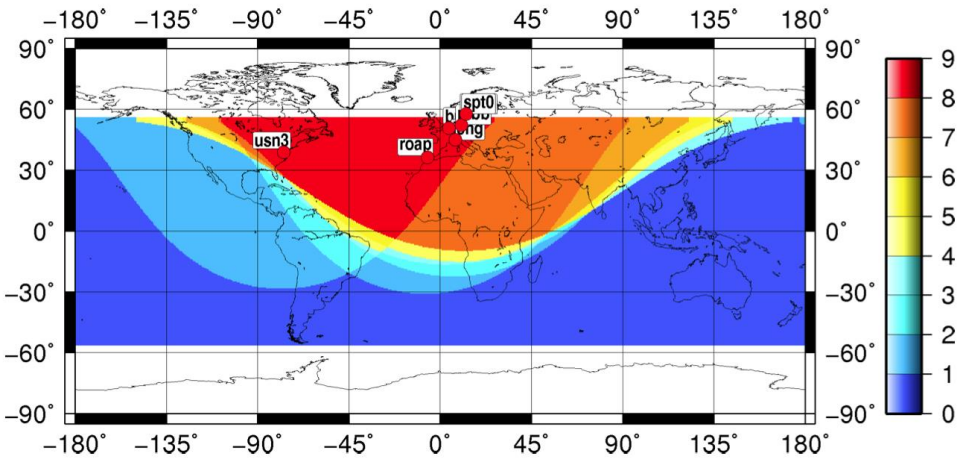
- ODTS stands for *Orbit Determination & Time Synchronization*
- ODTS is a batch least-squared estimator processing dual-frequency pseudorange and carrier phase measurements from a GNSS station network, and minimizing measurement *residuals*; GPS and GLONASS supported
- Measurements are processed in batches (*arcs*) of typically 2-day to 5-day duration; execution time less than one minute for 8 stations and 2 days (on GMV server)
- Main outputs are satellite orbits+clocks and **station clocks**
- Other estimated parameters: tropo delay, satellite radiation coefficients, phase ambiguities (floating), station coordinates (optional)
- IGS Conventions followed, Earth Rotation parameters coming from IERS
- Clocks offsets are unmodeled, they are estimated as instantaneous and independent values (*snapshot*) at the measurement timestamp, typically at a rate of **5 min** or **30 sec**
- One station in the network must be chosen as **reference clock**: all resulting clock offsets are given with respect to this reference clock
- Station biases are uncalibrated: the resulting clocks are *apparent clocks* containing the station internal delays and their instabilities

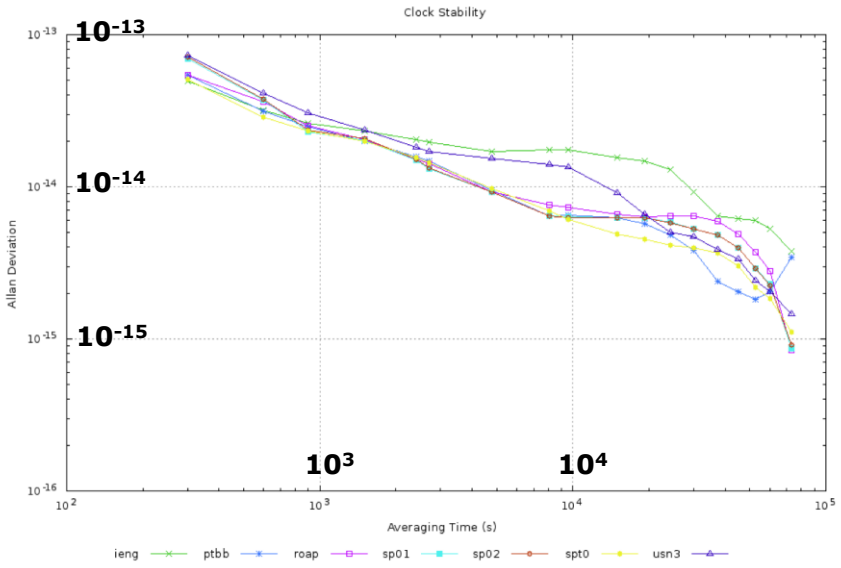
Iteration Number	RMS of Weighted Residuals	Delta RMS of Weighted Residuals	RMS of Code Residuals m	RMS of Phase Residuals m
0	10188.475	-	87.115	86.696
1	1.685	10186.790	0.227	0.013
2	0.837	0.848	0.219	0.005
3	0.814	0.023	0.217	0.005
4	0.806	0.008	0.216	0.004
5	0.802	0.004	0.216	0.004



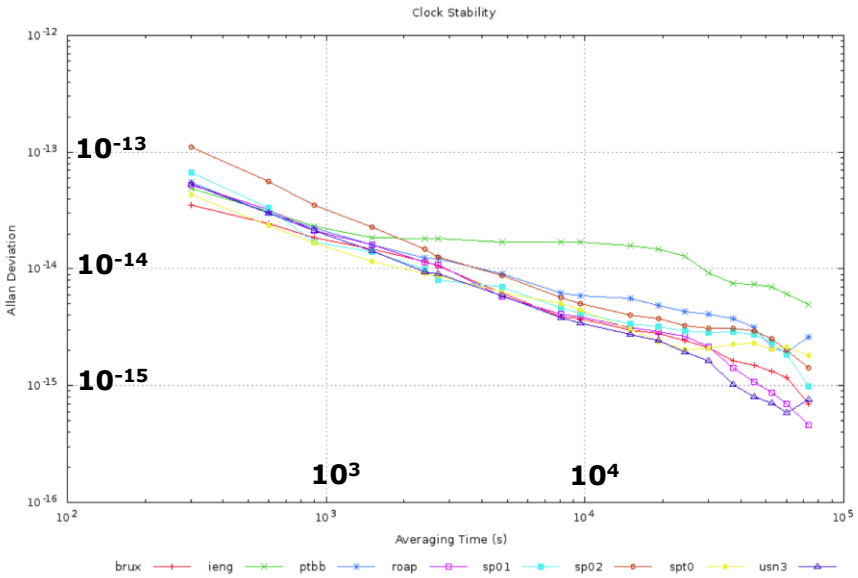
WHAT IS ODTS (2)

- Normally a global network of stations is needed but *regional* ODTS is also possible, using a sparse network
- Globally, satellite orbit+clock are "bad" due to lack of coverage
- But satellite orbit+clock errors largely cancel out over the area of interest ➔ station clocks are precise!
- Exception are "isolated" stations, with apparent clock slightly noisier (e.g., USN3); can be improved adding IGS data





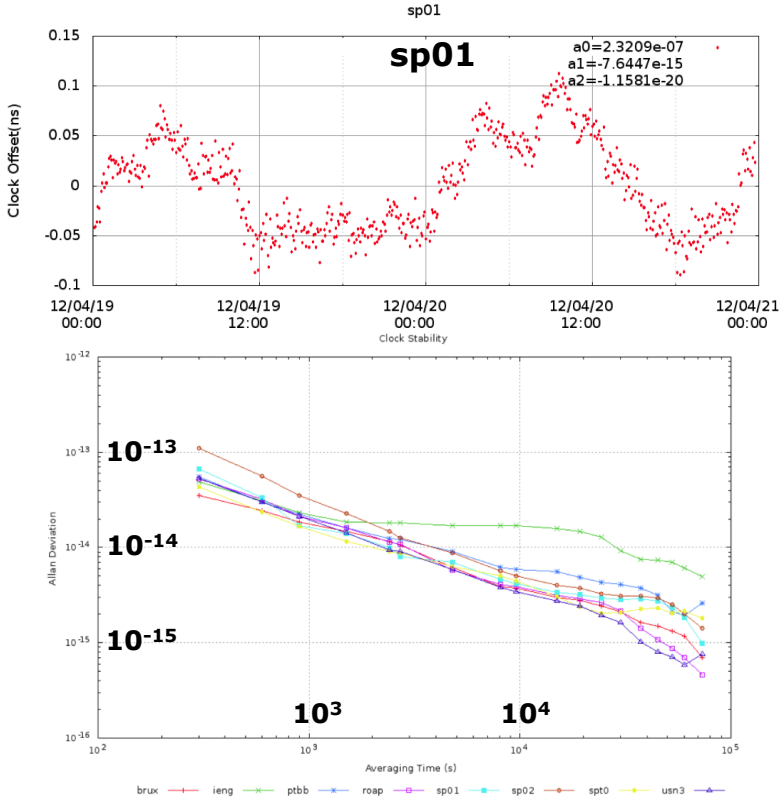
from ODTS



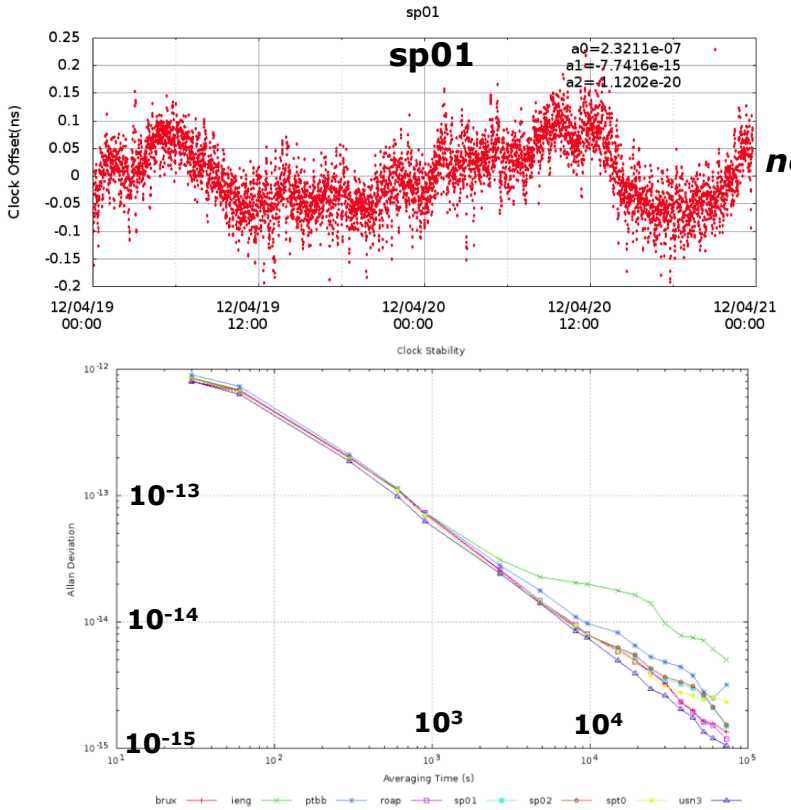
from PPP (IGS *rapid* products)

ADVANTAGES OF ODTS VS PPP

- No dependance on timeliness and quality of orb+clk *products* ➔ more robust and operational
- Only station measurements needed (RINEX files); easy to use, web-based, no installation
- A moderately dense network required, *regional* ODTS also possible
- Latency can be improved using 15-min RINEX files; fast execution time (1 min)
- No added clock noise due to sat clock interpolation: 30-sec rate is possible (even higher)



PPP @ 5 min (IGS rapid products)



noise!

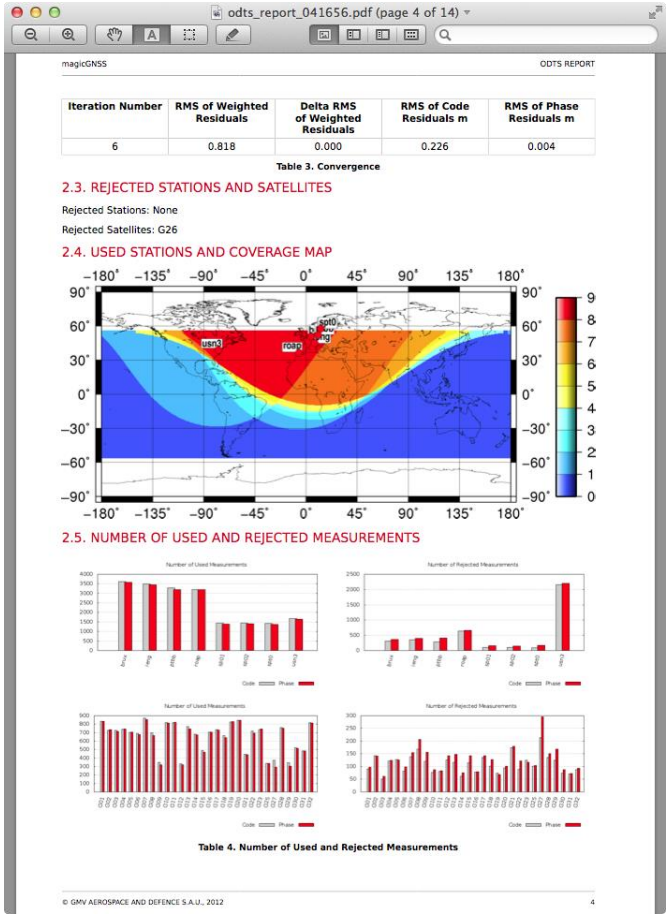
PPP @ 30 sec (IGS rapid products) = interpolation

magicGNSS (1)

- *magicGNSS* is a web application for GNSS data processing

magicgnss.gmv.com

- One-month trial account can be requested online for free
- The user can upload RINEX measurement files (daily, hourly, 15-min), via web and ftp; ftp upload can be automated on the station side
- ODTS and PPP algorithms available (both supporting GPS and GLONASS); 5-min and 30-sec data rates supported in PPP and ODTS
- For ODTS, data from IGS stations internally available to "fill the gaps" (*core stations*)
- For PPP, IGS *final*, *rapid* or *ultra-rapid* products (sat orbit+clock) can be used, as available (GPS only)
- GMV internal *rapid* and *ultra-rapid* products for PPP are also available (GPS+GLONASS)
- A Scheduler is provided to automate ODTS/PPP executions (as often as every hour)
- GPS & GLONASS NANUs are automatically processed and unhealthy satellites discarded
- Very easy to use, full PDF reports provided (ODTS and PPP)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magicGNSS ODTS REPORT

Iteration Number	RMS of Weighted Residuals	Delta RMS of Weighted Residuals	RMS of Code Residuals m	RMS of Phase Residuals m
6	0.818	0.000	0.226	0.004

Table 3. Convergence

2.3. REJECTED STATIONS AND SATELLITES

Rejected Stations: None

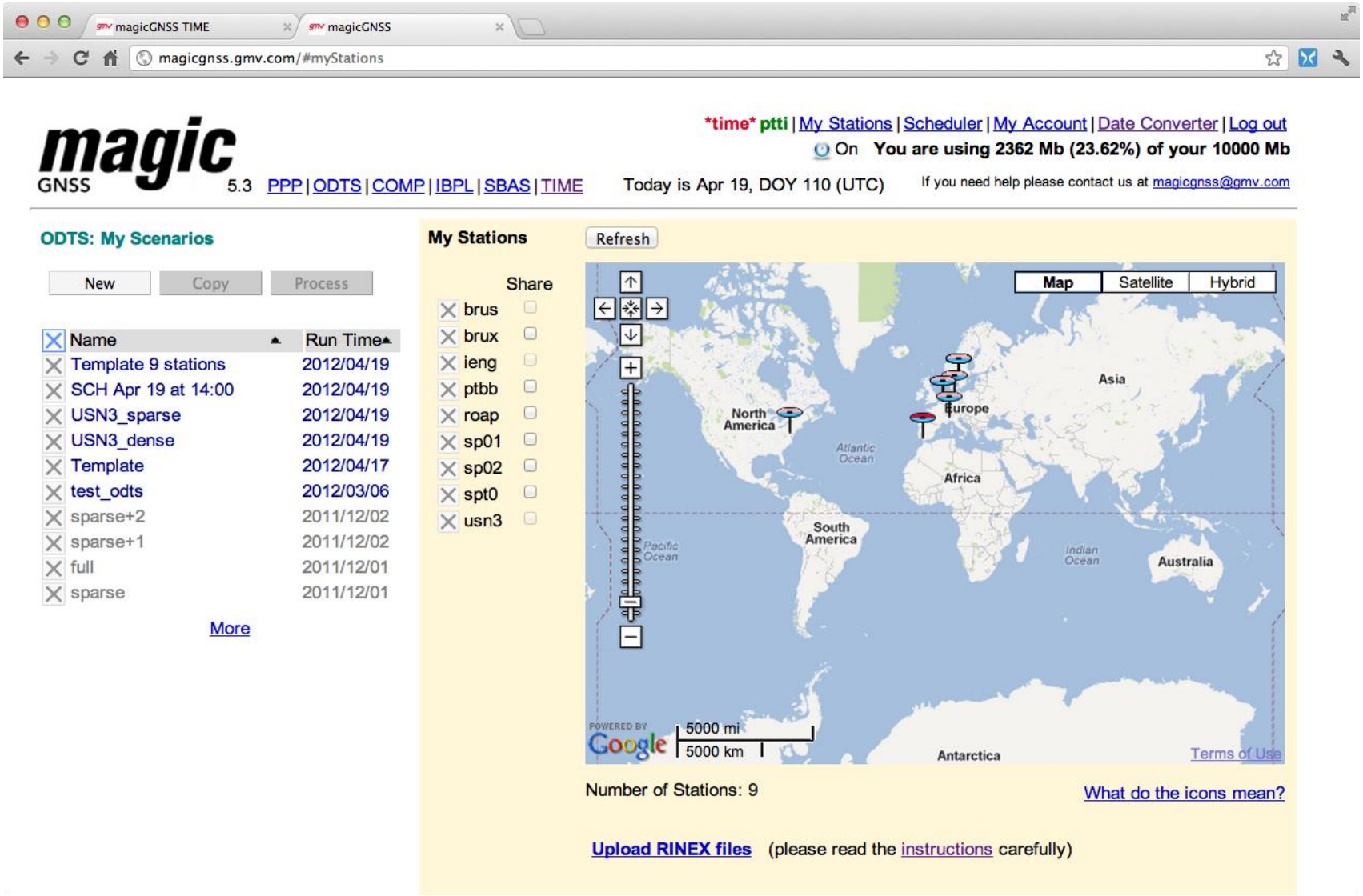
Rejected Satellites: G26

2.4. USED STATIONS AND COVERAGE MAP

2.5. NUMBER OF USED AND REJECTED MEASUREMENTS

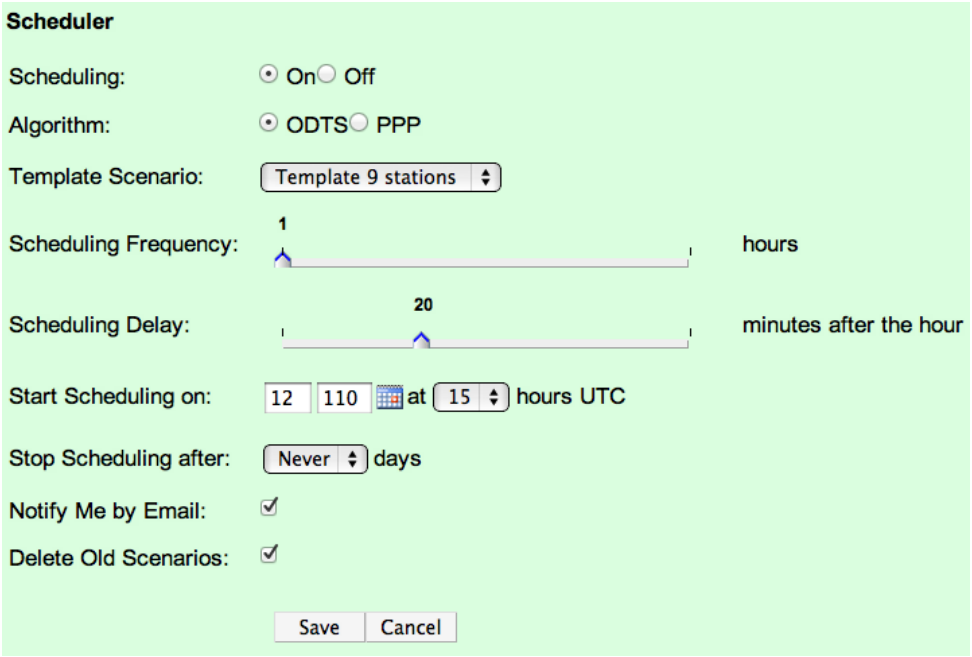
Table 4. Number of Used and Rejected Measurements

magicGNSS (2)

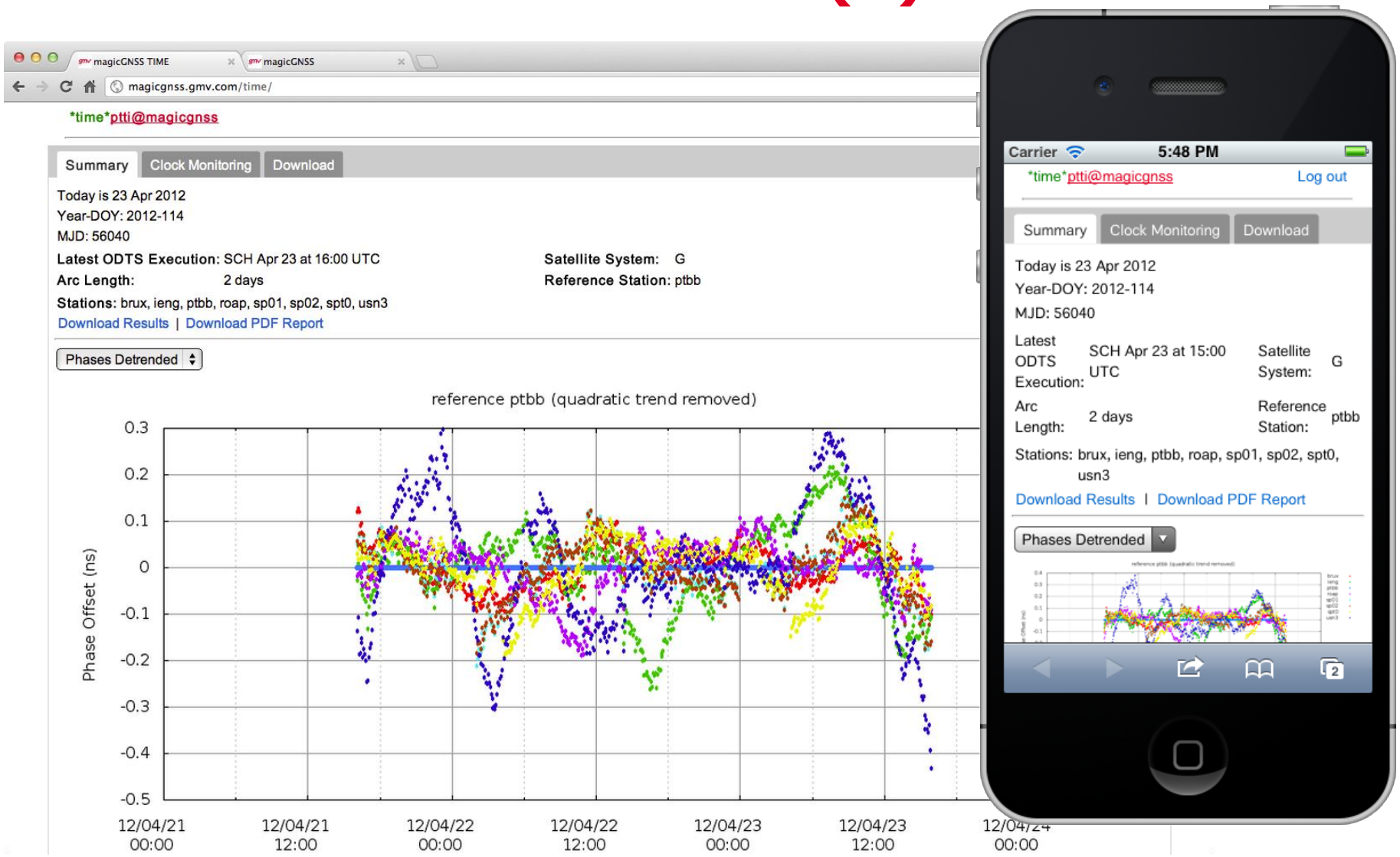

magicGNSS TIME
magicGNSS
magicgnss.gmv.com/#myStations
magic GNSS 5.3
PPP | ODTS | COMP | IBPL | SBAS | TIME
time ptti | My Stations | Scheduler | My Account | Date Converter | Log out
On You are using 2362 Mb (23.62%) of your 10000 Mb
Today is Apr 19, DOY 110 (UTC)
If you need help please contact us at magicgnss@gmv.com
ODTS: My Scenarios
New
Copy
Process
Name
Run Time
Template 9 stations 2012/04/19
SCH Apr 19 at 14:00 2012/04/19
USN3_sparse 2012/04/19
USN3_dense 2012/04/19
Template 2012/04/17
test_odts 2012/03/06
sparse+2 2011/12/02
sparse+1 2011/12/02
full 2011/12/01
sparse 2011/12/01
More
My Stations
Refresh
Share
brus
brux
ieng
ptbb
roap
sp01
sp02
spt0
usn3
Map
Satellite
Hybrid
North America
Europe
Asia
Africa
South America
Australia
Atlantic Ocean
Pacific Ocean
Indian Ocean
Antarctica
5000 mi
5000 km
Terms of Use
Number of Stations: 9
What do the icons mean?
Upload RINEX files (please read the instructions carefully)

THE TIMING ACCOUNT (1)

- A special *magicGNSS* *time* account provides additional support for clock evaluation via web and smartphone
- Results are based on ODTS executions every hour using the Scheduler (ODTS runs 20 min after the hour, to accommodate for RINEX file arrival)
- The different timing labs automatically upload via ftp hourly RINEX files to a shared *magicGNSS* account (password protected); results are monitored by INRiM and GMV
- This is a collaborative job and timely upload of RINEX files is fundamental
- Clock monitoring results are available at **magicgnss.gmv.com/time**
- Only clock results are shown, ODTS complexity is hidden
- The user can concentrate on clock behavior and react quickly to possible anomalies

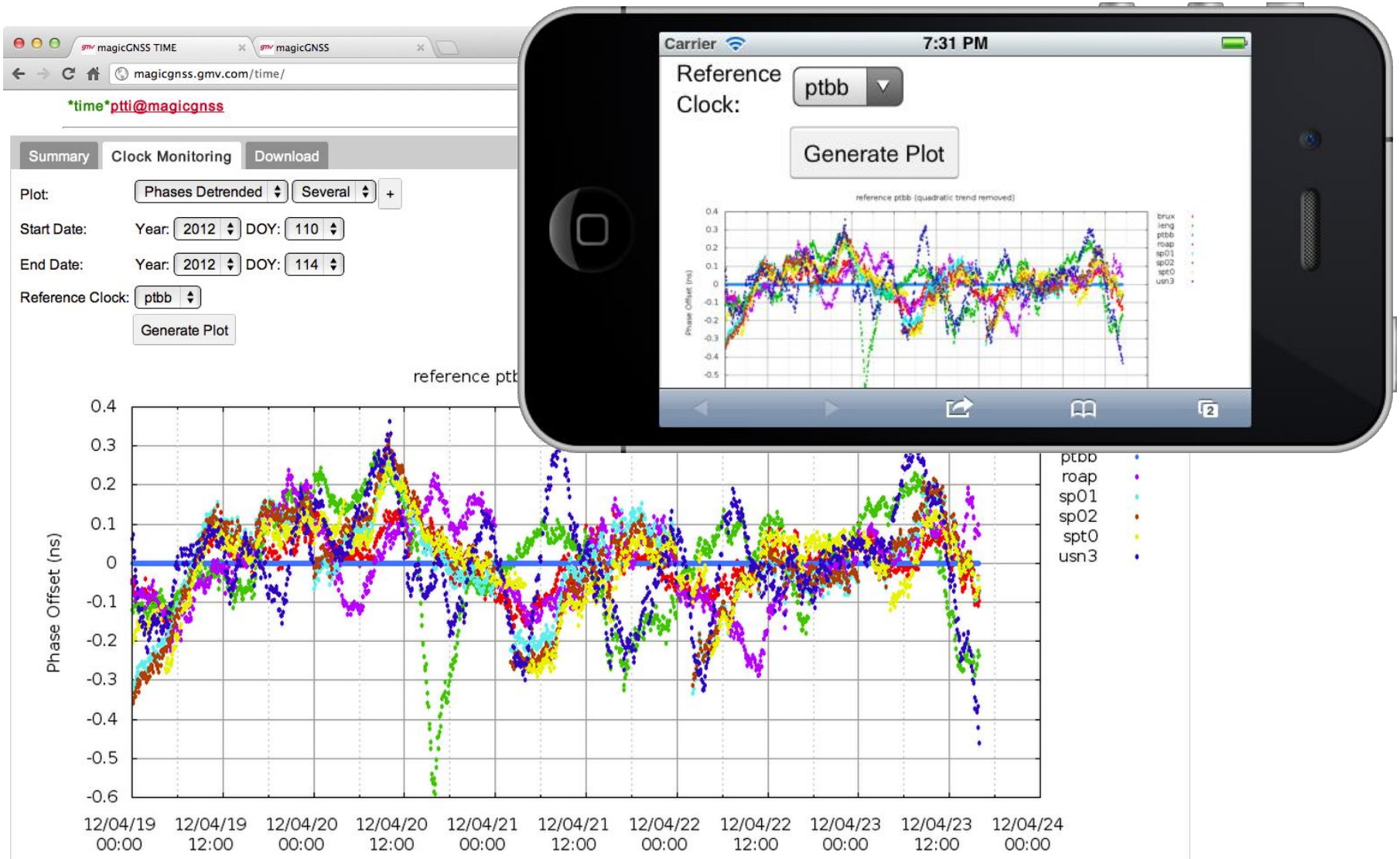


THE TIMING WEB & APP (1)



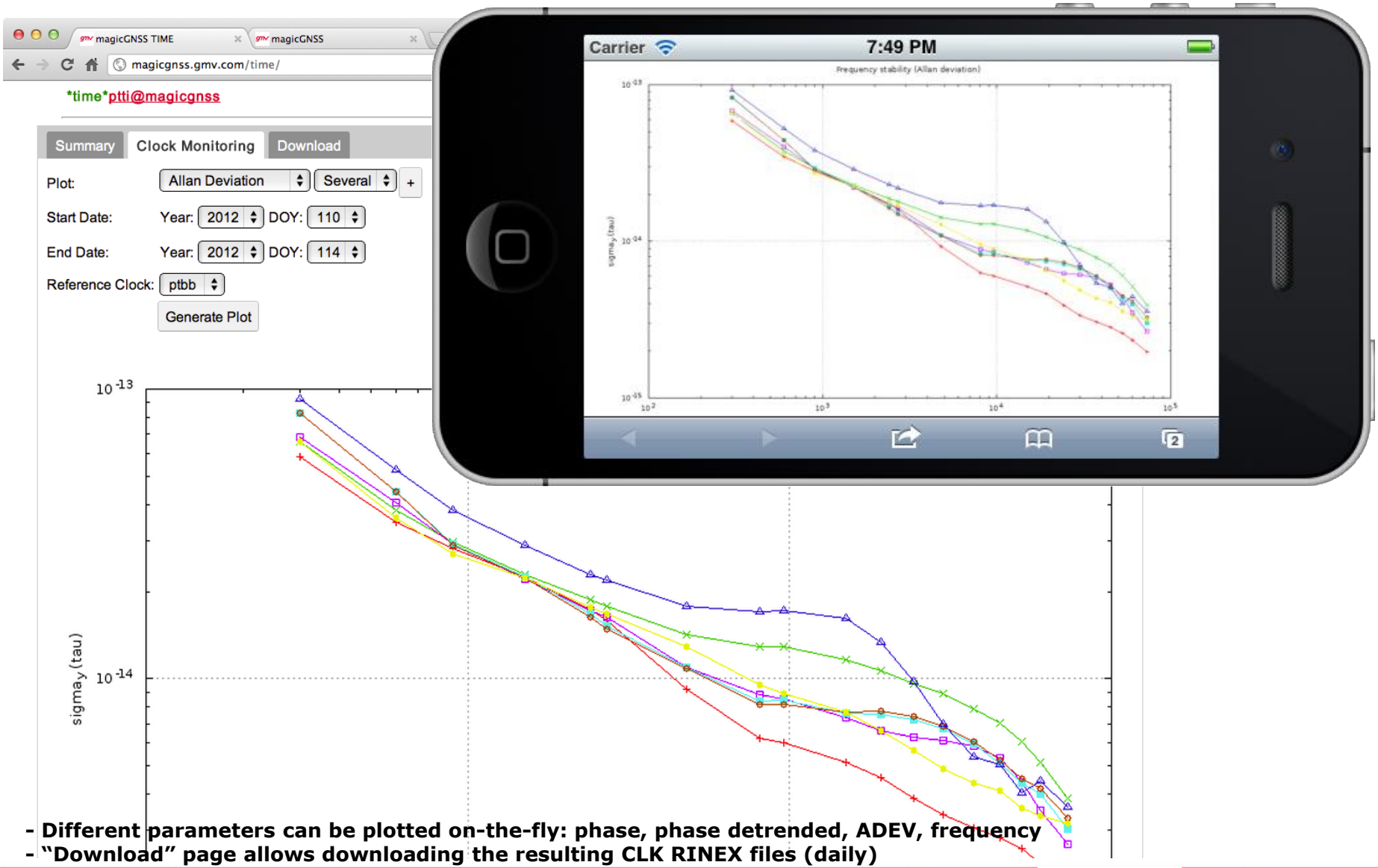
- Three pages: "Summary", "Clock Monitoring", "Download"
- "Summary" page shows the latest execution (20 min after integer hour)

THE TIMING WEB & APP (2)



- **"Clock Monitoring" page allows plotting multiple days of the clock evolution**
- **Reference clock can be changed dynamically without having to re-run ODTS**

THE TIMING WEB & APP (3)



- **Different parameters can be plotted on-the-fly: phase, phase detrended, ADEV, frequency**
- **"Download" page allows downloading the resulting CLK RINEX files (daily)**

CONCLUSIONS

- ODTS can be used to monitor GNSS station clocks in near-real time
- Only RINEX measurement files from station needed (hourly), and an ftp client
- No dense worldwide station network required, ODTS works regionally
- ODTS does not depend on timeliness/quality of satellite orb+clk input products
- Small latency, high robustness
- Web-based with *magicGNSS*, no need to install+learn software
- Very easy to use, no prior knowledge required
- Just upload your RINEX files and watch the results on the web or your phone
- Output clock quality similar to PPP and IGS results
- Almost one year running smoothly on GMV server
- So far just one weekend downtime due to scheduled maintenance

Thank you

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