CODE's multi-GNSS orbit and clock solution - status 2016

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EGU General Assembly, 17-22 April 2016,
Vienna, Austria

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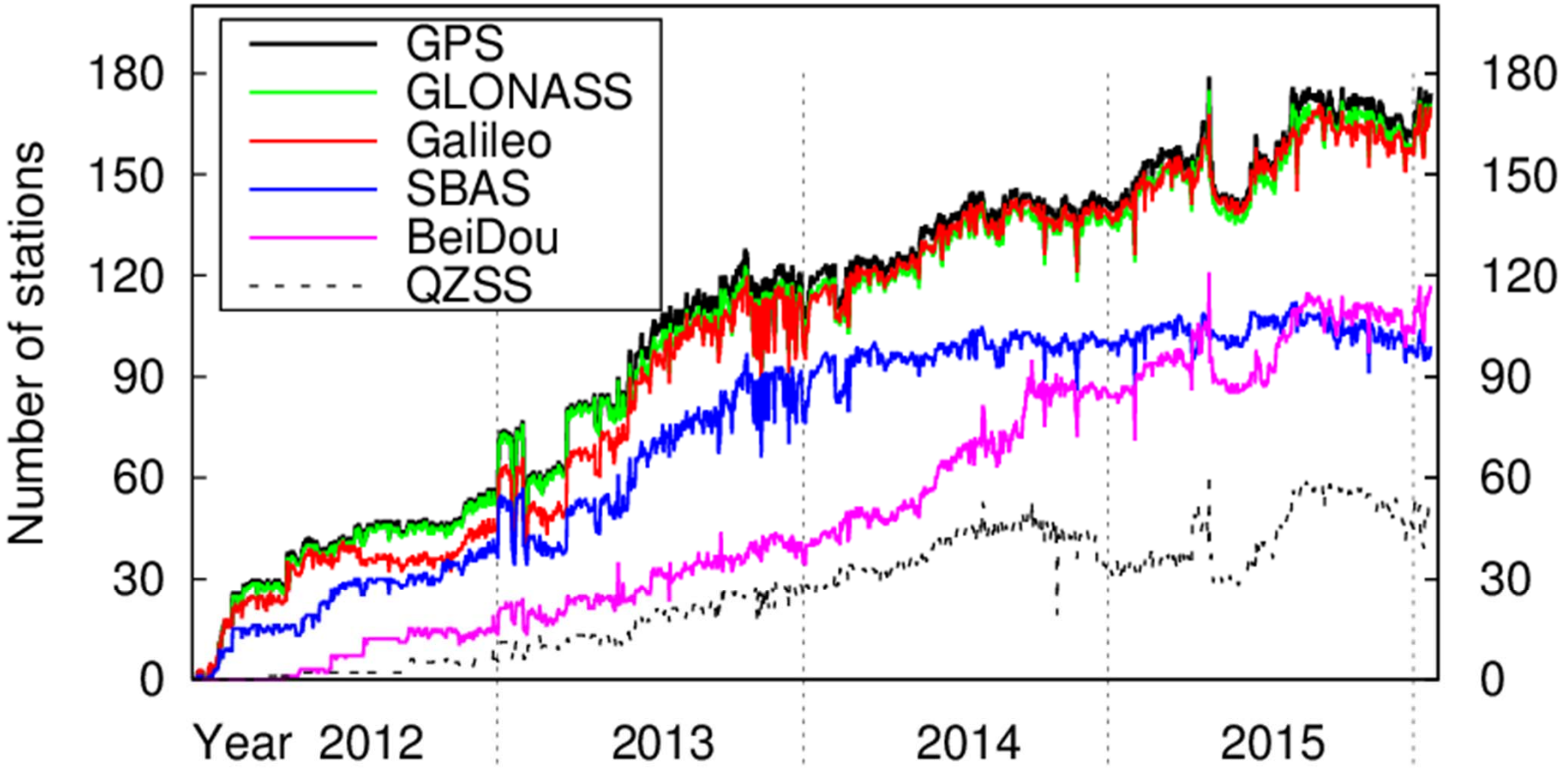
MGEX data monitoring

Number of stations providing daily RINEX3 files and included in CODE‘s raw data monitoring (data sources: IGS-MGEX and EPN)



CODE MGEX orbit solution

GNSS considered:	**GPS + GLONASS + Galileo + BeiDou** (MEO+IGSO) + **QZSS** (≈70 SV)
Processing mode:	Post-processing (≈2 weeks latency)
Timespan covered:	GPS-weeks 1689 - today
Number of stations:	130 (GPS), 110 (GLONASS), 85 (Galileo); 55 (BeiDou); 20 (QZSS)
Processing scheme:	**Double-difference** network processing (observable: phase double differences)
Signal frequencies:	L1+ L2 (GPS + GLO+ QZSS); E1 (L1) + E5a (L5) Galileo; B1 (L1) + B2 (L7) BeiDou
Orbit characteristic:	3-day long arcs; SRP: ECOM / ECOM2 (since 2015)
Reference frame:	IGS08 (until week 1708); IGb08 (since week 1709)
IERS conventions:	IERS2003 (until 1705); IERS2010 (since 1706)
Product list:	Daily orbits (SP3) and ERPs
Distribution:	ftp://cddis.gsfc.nasa.gov/gnss/products/mgex/ and ftp://ftp.unibe.ch/aiub/CODE_MGEX/
Designator:	comwwwwd.???.Z

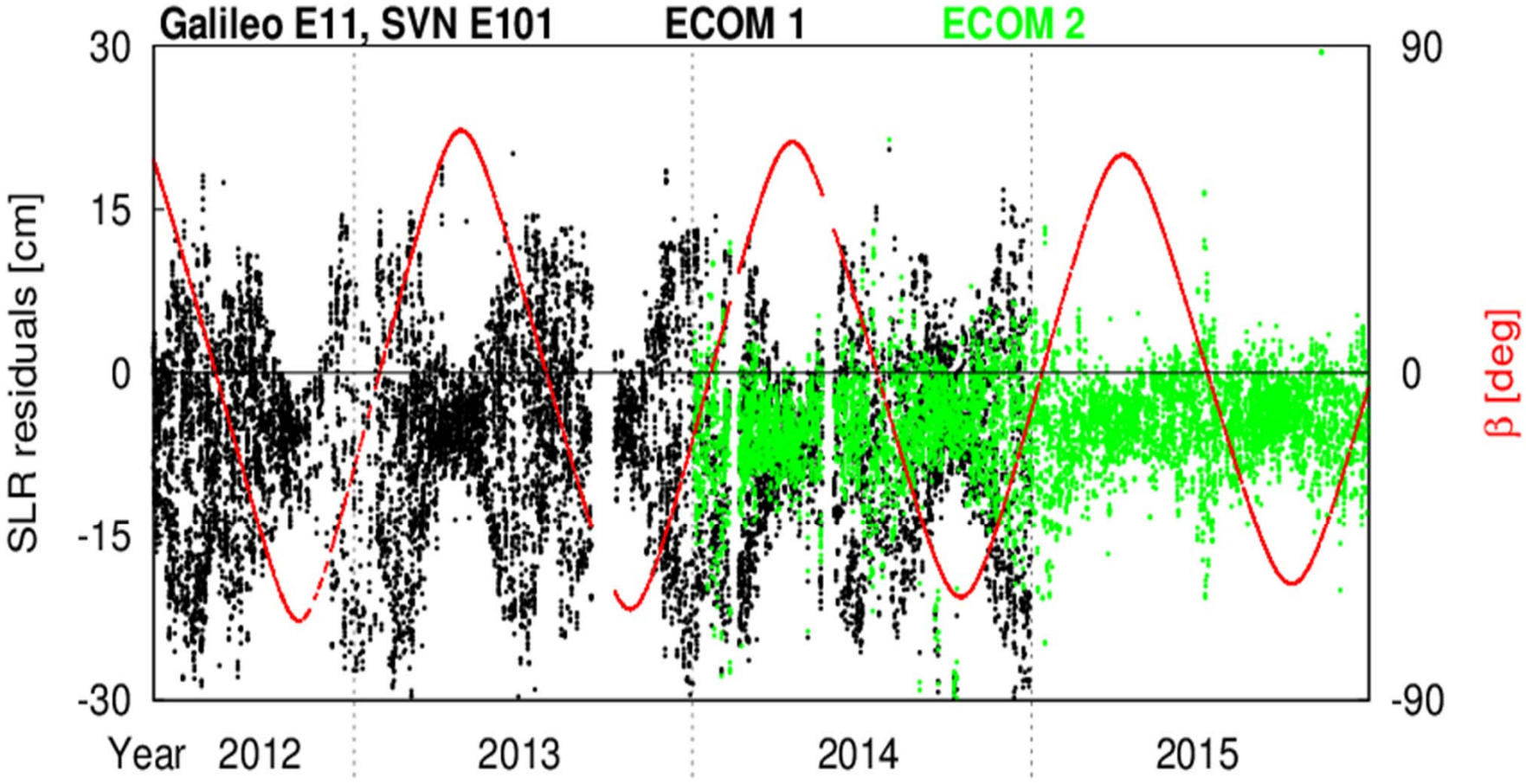
CODE MGEX clock solution

GNSS considered:	**GPS + GLONASS + Galileo + BeiDou + QZSS** (≈70 SV)
Processing mode:	Post-processing (≈2 weeks latency)
Timespan covered:	GPS-weeks 1710 - today
Number of stations:	130 (GPS), 35 (GLO), 45 (Galileo); 50 (BeiDou); 20 (QZSS)
Processing scheme:	**Zero-difference** processing (observable: code+phase undifferenced)
Signal frequencies:	L1+ L2 (GPS + GLO+ QZSS); E1 (L1) + E5a (L5) Galileo; B1 (L1) + B2 (L7) BeiDou
A priori information:	Orbits, ERPs, coordinates, and troposphere from CODE MGEX orbit solution introduced as known
Reference frame:	IGb08
IERS conventions:	IERS2010
Product list:	Epoch-wise (300s) satellite and station clock corrections in daily clock RINEX files; daily inter-system biases for mixed stations in Bernese DCB and BIAS-SINEX format
Distribution:	ftp://cddis.gsfc.nasa.gov/gnss/products/mgex/ and ftp://ftp.unibe.ch/aiub/CODE_MGEX/

Changes w.r.t. to IGS solution

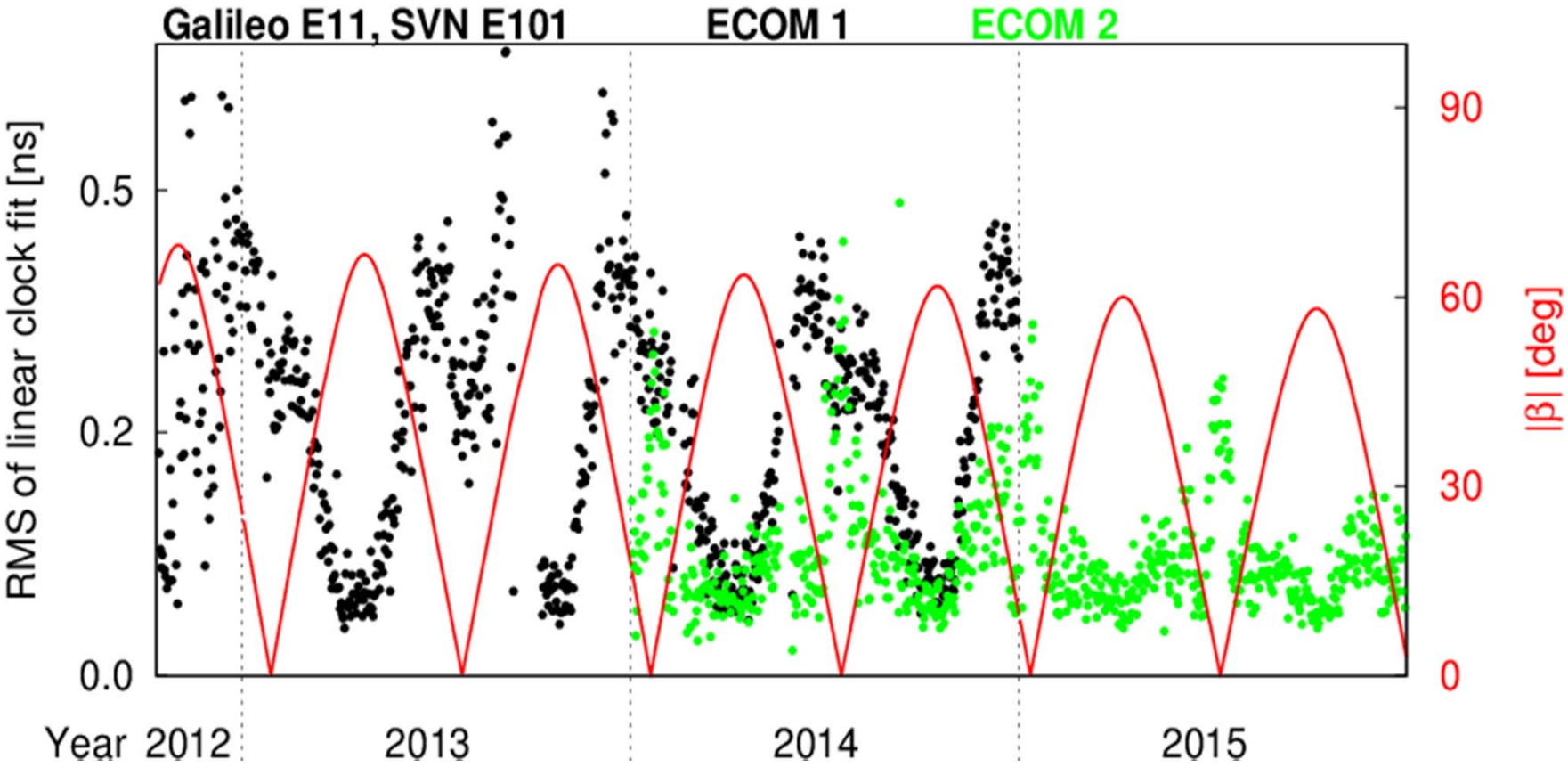
- Implementation of Galileo, QZSS, BeiDou (except GEOs)
- Use of RINEX3 files from MGEX network; selection of observation types
- Improved SRP model for yaw-steering attitude (ECOM2, Arnold et al., 2015)
- Normal attitude and related SRP models for QZSS and BeiDou
- ANTEX (PCO+PCV) for Galileo, QZSS, BeiDou
- Attitude laws for GPS, GLONASS, (Galileo?) eclipses
- Proper handling of observation biases
- Ambiguity resolution for Galileo, BeiDou, QZSS
- Albedo radiation modelling for Galileo, QZSS, BeiDou
- Antenna thrust for (GLONASS), Galileo, QZSS, BeiDou

Galileo orbit validation



⇒ Significant reduction of dependency on beta-angle, when changing to the ECOM2 (attitude related?)

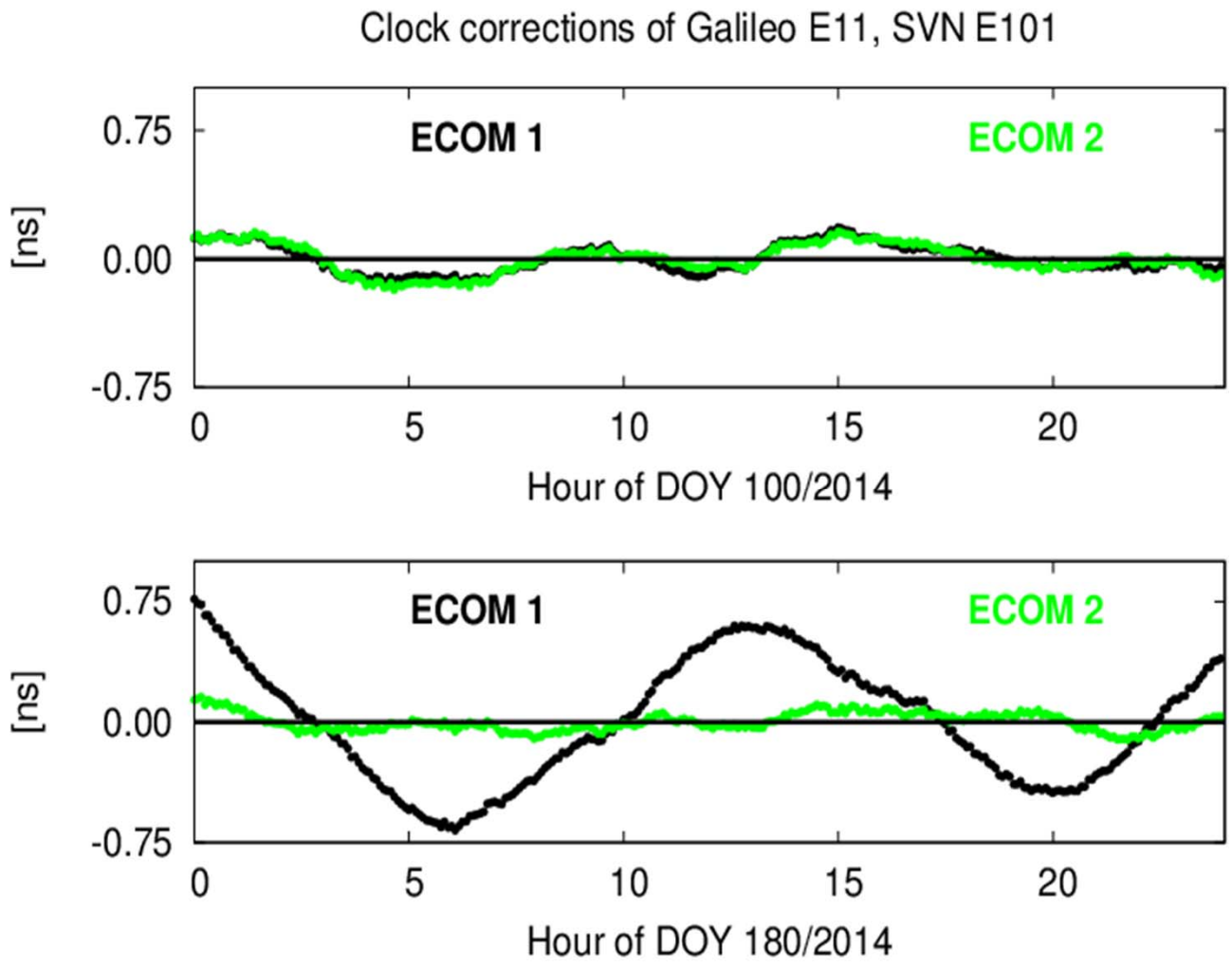
Galileo clock validation



⇒ Significant reduction of dependency on beta angle

⇒ Pronounced signal remains during eclipse season or close-by (attitude related?)

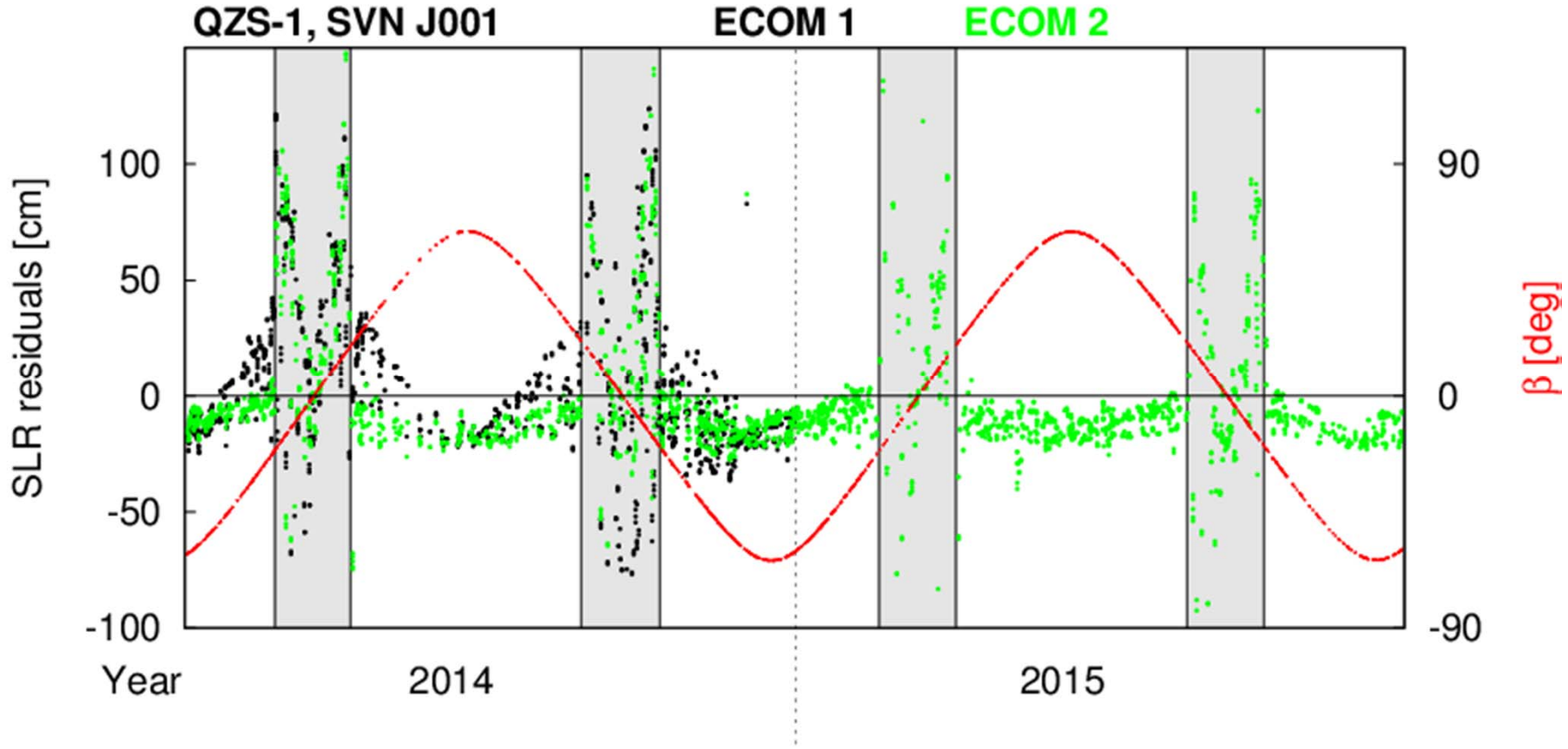
Galileo clock validation



Large beta-angle:
=> Clock signal has small amplitude (about ±0.15 ns)

Small beta-angle:
=> Periodic signal caused by mis-modelled orbit (ECOM1)
=> Significant reduction of signal amplitude from ±0.75 ns to ±0.15 ns when switching to ECOM2

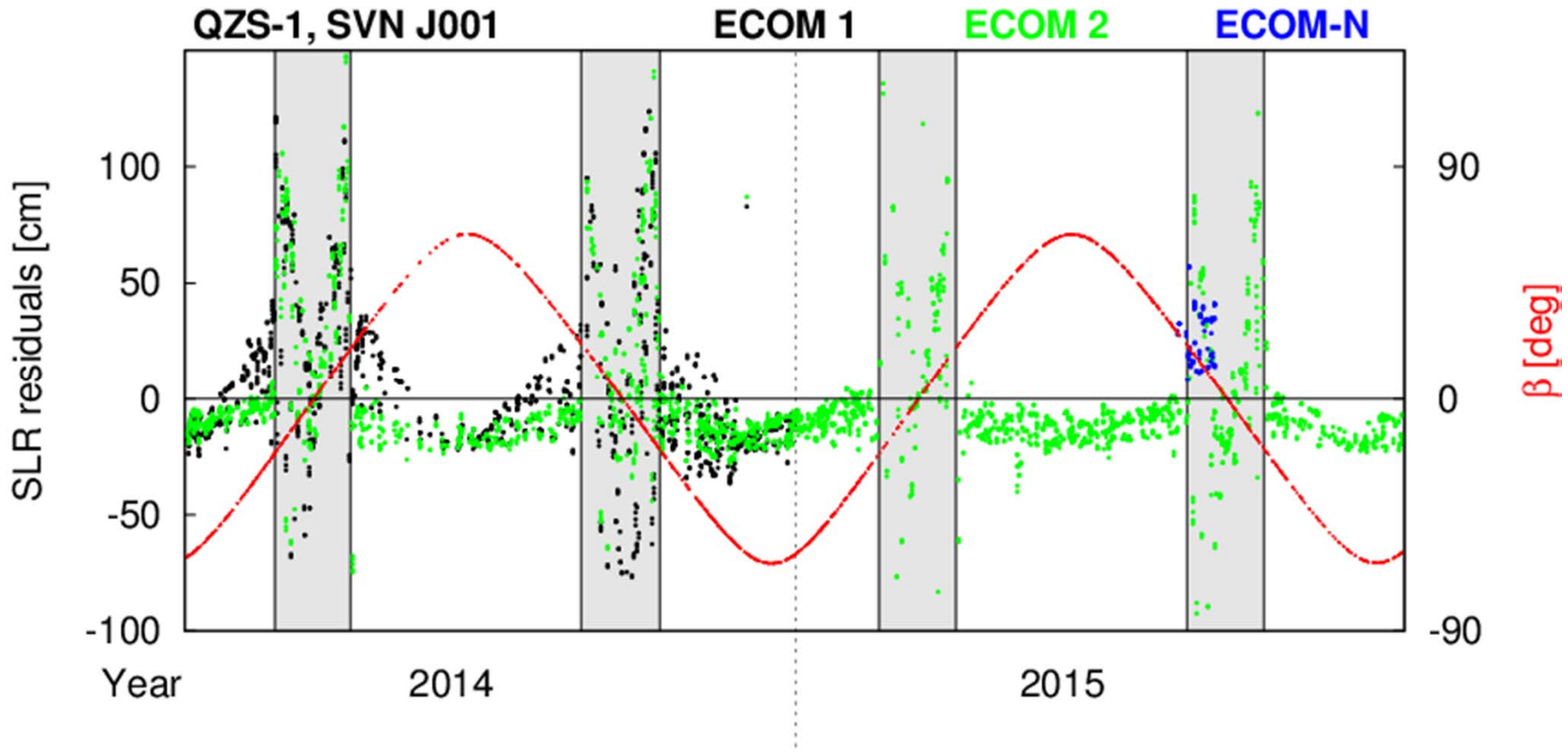
QZSS orbit validation



⇒ Yaw-steering: ECOM2 reduces dependency on beta angle

⇒ Significant SLR offset remains

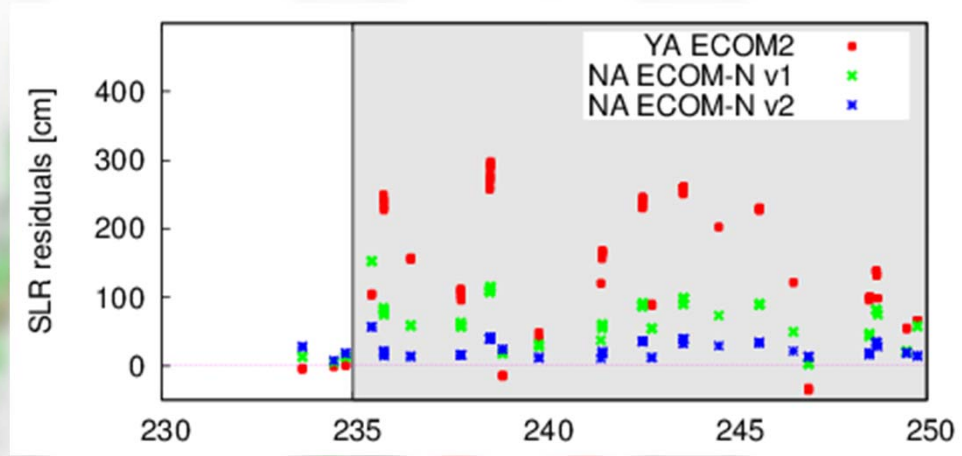
QZSS orbit validation



⇒ Normal attitude mode (|ß| < 20°; marked grey): large orbit errors

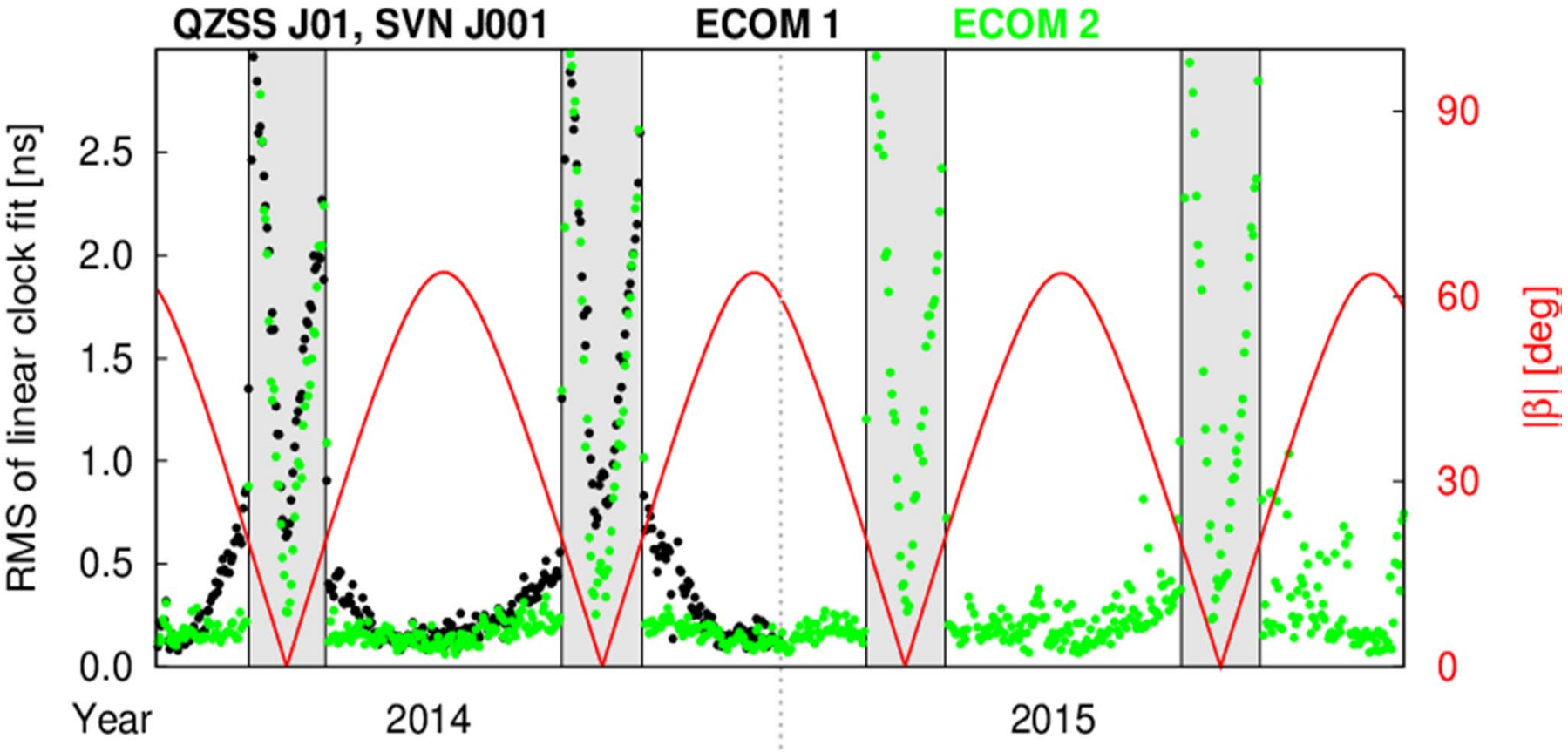
⇒ Test of new ECOM versions suited for orbit normal attitude mode

QZSS orbit validation



⇒ Test of new ECOM versions suited for orbit normal attitude mode

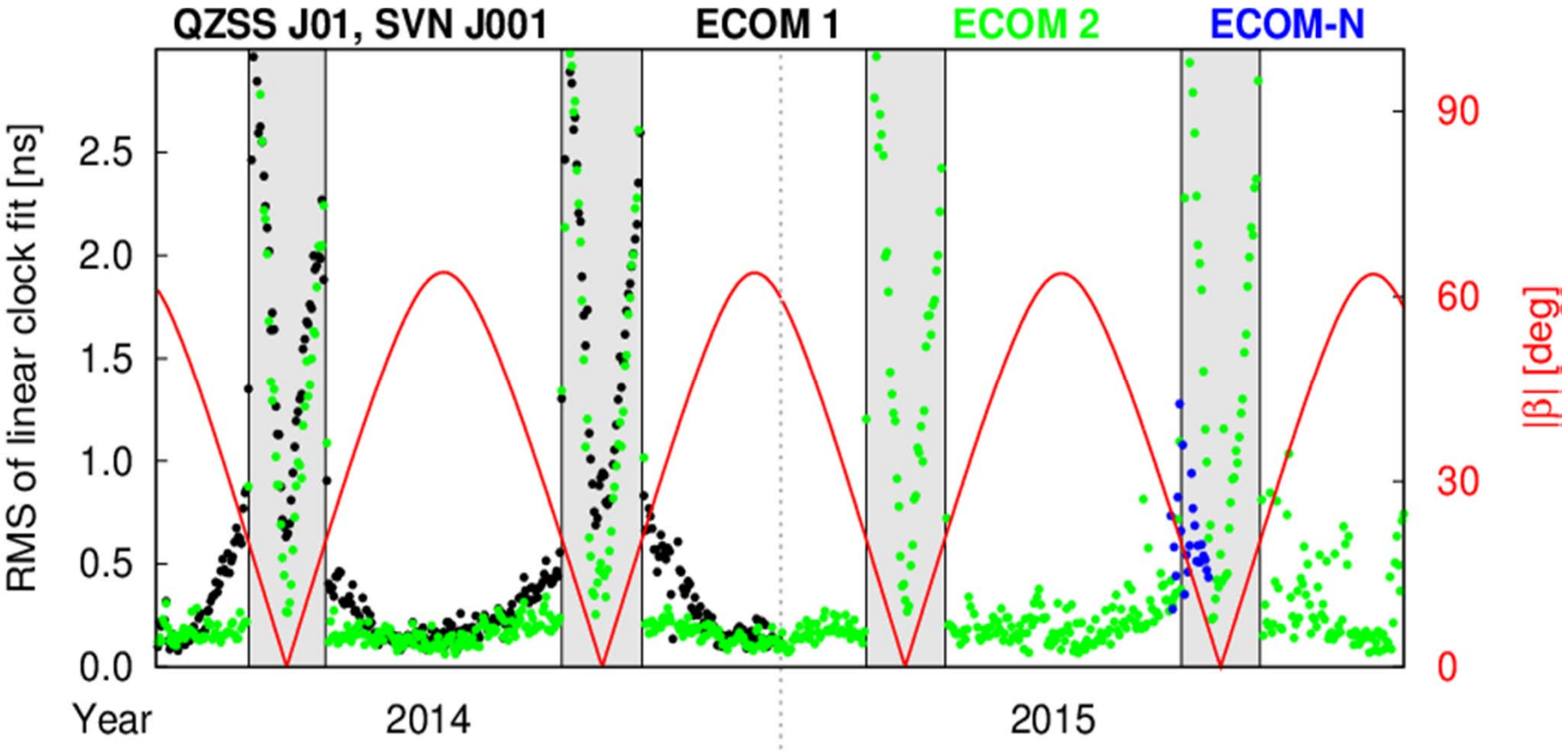
QZSS clock validation



⇒ Yaw-steering: significant reduction of dependency on beta angle thanks to ECOM2

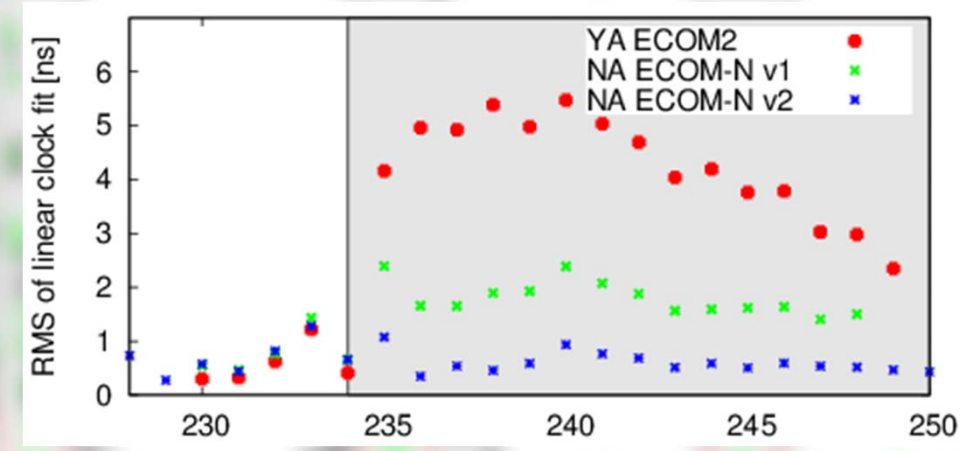
⇒ Orbit normal attitude mode (grey): large errors remain

QZSS clock validation



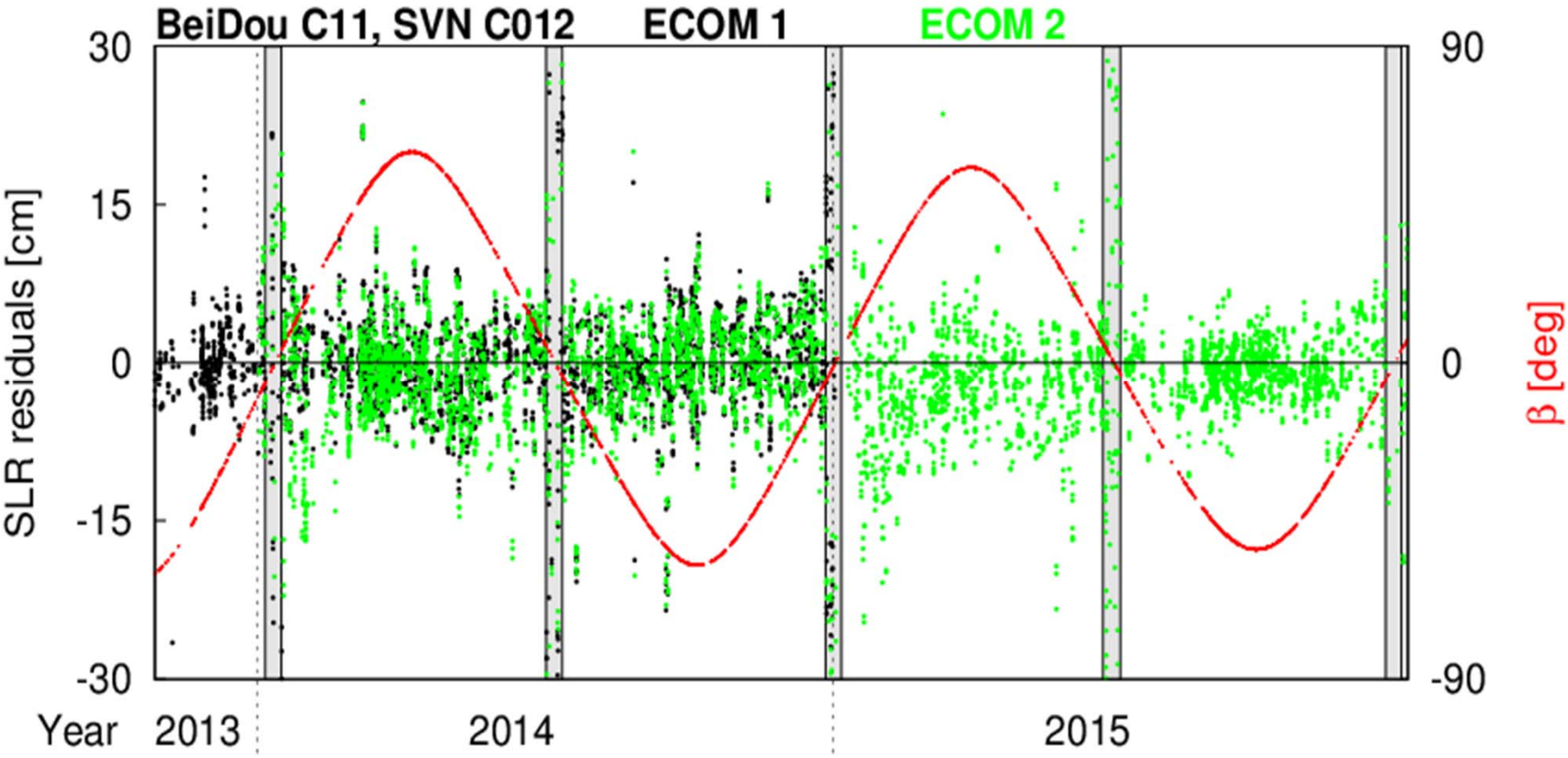
⇒ Experiments with ECOM versions better suited for orbit normal attitude mode

QZSS clock validation



⇒ Experiments with ECOM versions better suited for orbit normal attitude mode

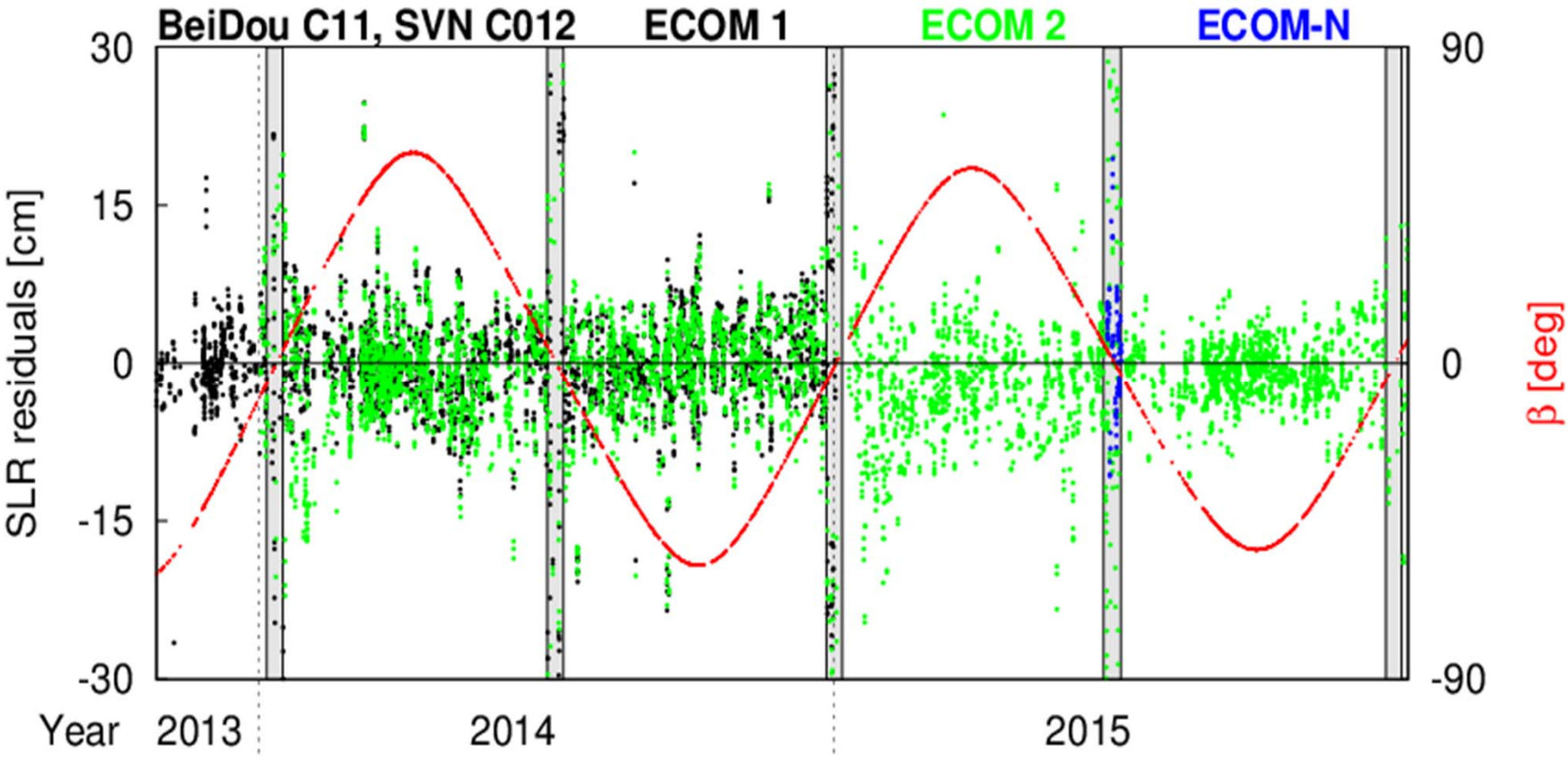
BeiDou orbit validation



⇒ Yaw-steering: no significant impact of ECOM version

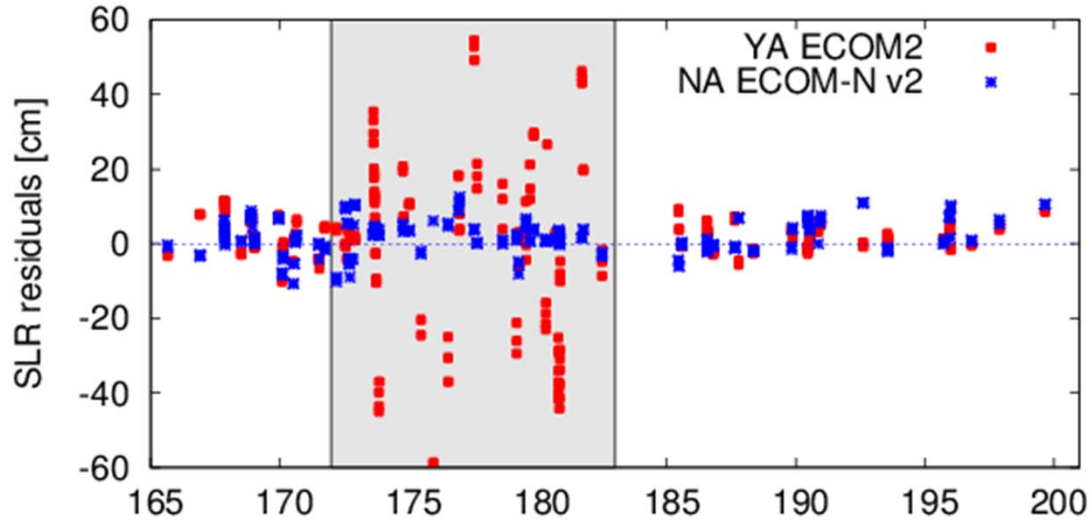
⇒ Orbit normal attitude mode (|ß| < 4°; grey boxes; not correctly considered): large residuals

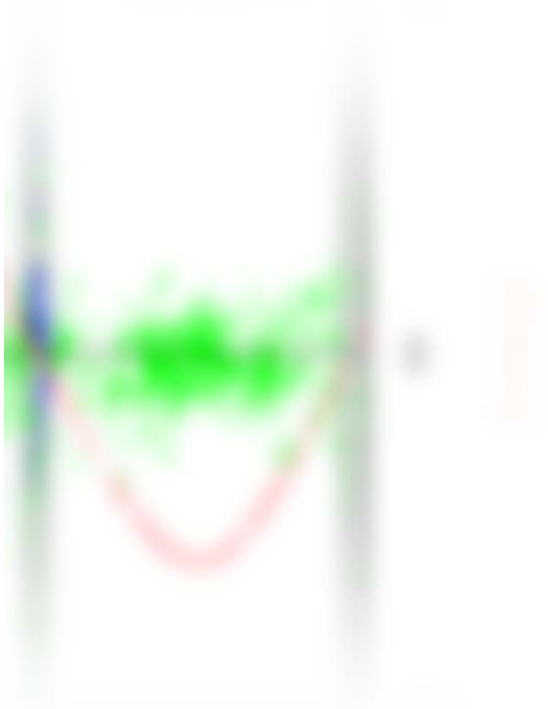
BeiDou orbit validation



⇒ Test of new ECOM versions better suited for orbit normal attitude mode

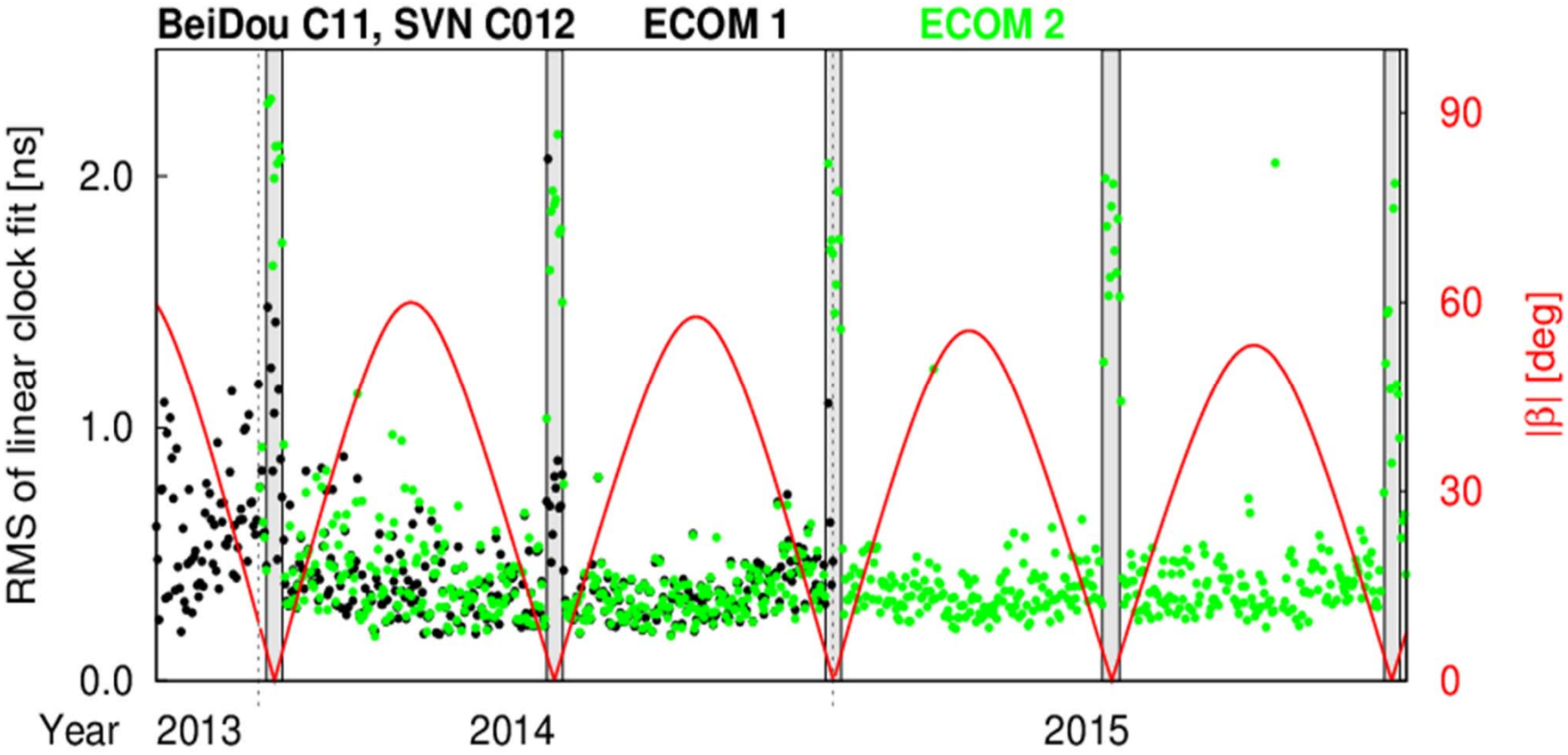
BeiDou orbit validation





⇒ Test of new ECOM versions better suited for orbit normal attitude mode

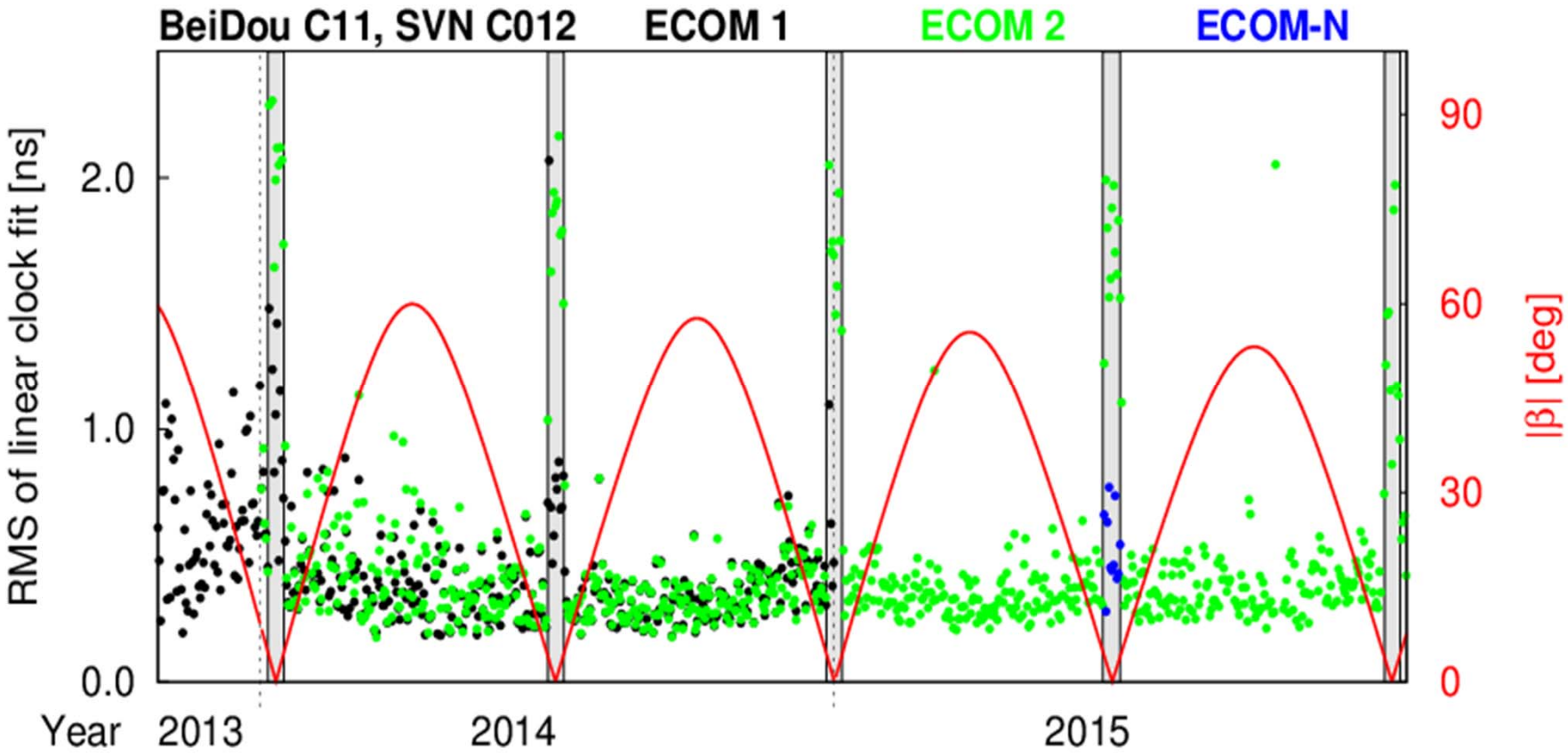
BeiDou clock validation



⇒ Yaw-steering: no significant difference between ECOM versions

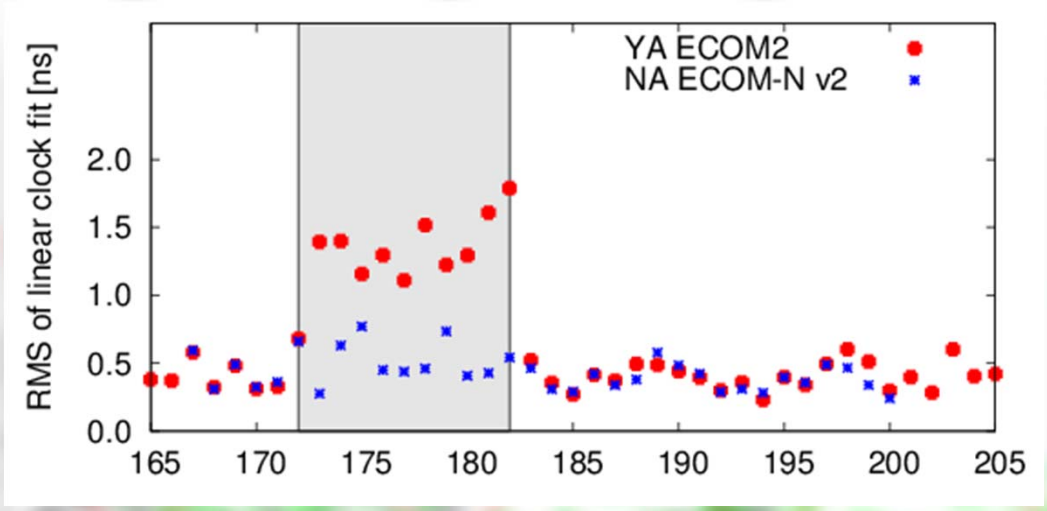
⇒ Orbit normal attitude mode (|ß| < 4°, marked grey; wrong attitude considered): ECOM2 may even degrade solution

BeiDou clock validation



⇒ Experiments with ECOM versions better suited for orbit normal attitude mode

BeiDou clock validation



⇒ Experiments with ECOM versions better suited for orbit normal attitude mode

Summary

- Still a long way to go until new GNSS can contribute to CODE's IGS solutions with the same quality as GPS
- Our current focus: correct consideration of orbit normal attitude (challenges are, e.g., SRP modelling, detection and consideration of mode-transitions, …)
- Next: use of published or own estimated transmitter antenna phase center corrections for Galileo, BeiDou, and QZSS
- Reprocessing of data from 2015 planned

Thank you

for

your interest!