How does radio-frequency interference (RFI) influence network RTK?

Results of a field test in Norway

Christian Rost, Tor-Ole Dahlø, Åsmund Skjæveland, Roger Hougen

Norwegian Mapping Authority, Geodetic Institute

Anders Rødningsby

Norwegian Defence Research Establishment

Göteborg, Sweden • 3 September 2014

MOTIVATION

Massive GPS Jamming Attack by North Korea

May 8, 2012 - By GPS World staff

Jersey Jammer Caper

Privacy Precludes GPS

JAMMING CELL PHONES AND GPS EQUIPMENT IS AGAINST THE LAW!

The Economist

Technology Quarterly:
Q1 2011

GPS jamming

No jam tomorrow

Navigation: As the uses of satellite-positioning technology continue to grow, what can be done to stop deliberate and dangerous jamming of the signals?

Mar 10th 2011 | From the prin

The Economist

GPS jamming

Out of sight

Satellite positioning-data are vital—but the signal is surprisingly easy to

Jul 27th 2013 | From the print edition

NEWS

Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

This is an unofficial announcement of Commission action. Release of the full text of a Commission order constit
See MCI v. FCC, 515 F 2d 385 (D.C. Cir. 1974).

FOR IMMEDIATE RELEASE:
June 19, 2014

FCC PLANS $34.9 MILLION FINE
AGAINST CHINESE ONLINE RETAILER OF SIGNAL JAMMING DEVICES
Warns U.S. Consumers that Importing and/or Operating a Signal Jammer is Unlawful

gpsworld.com

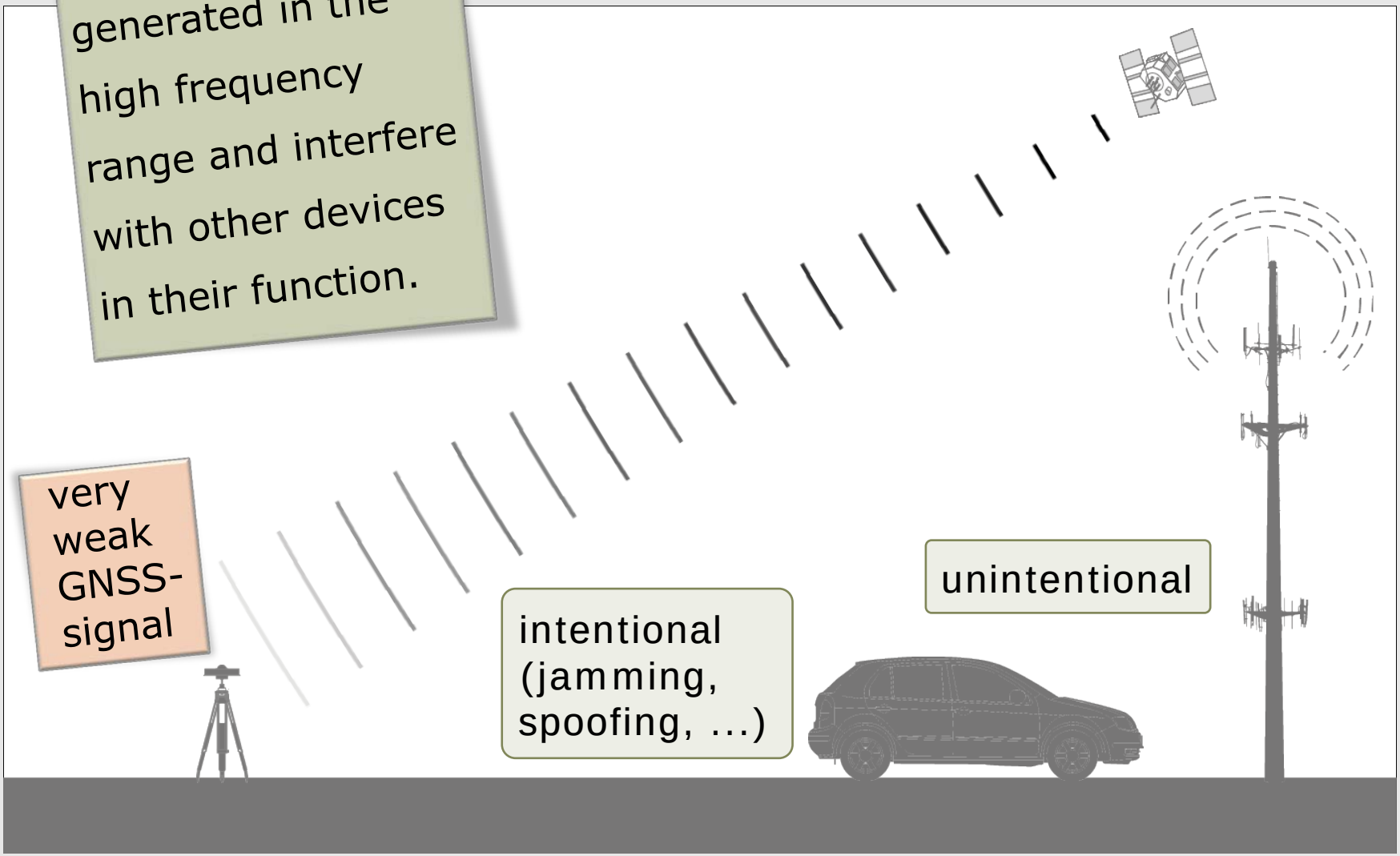
The Hunt for RFI: Unjamming a Coast Harbor

by Gps World Staff • 11 min read • original

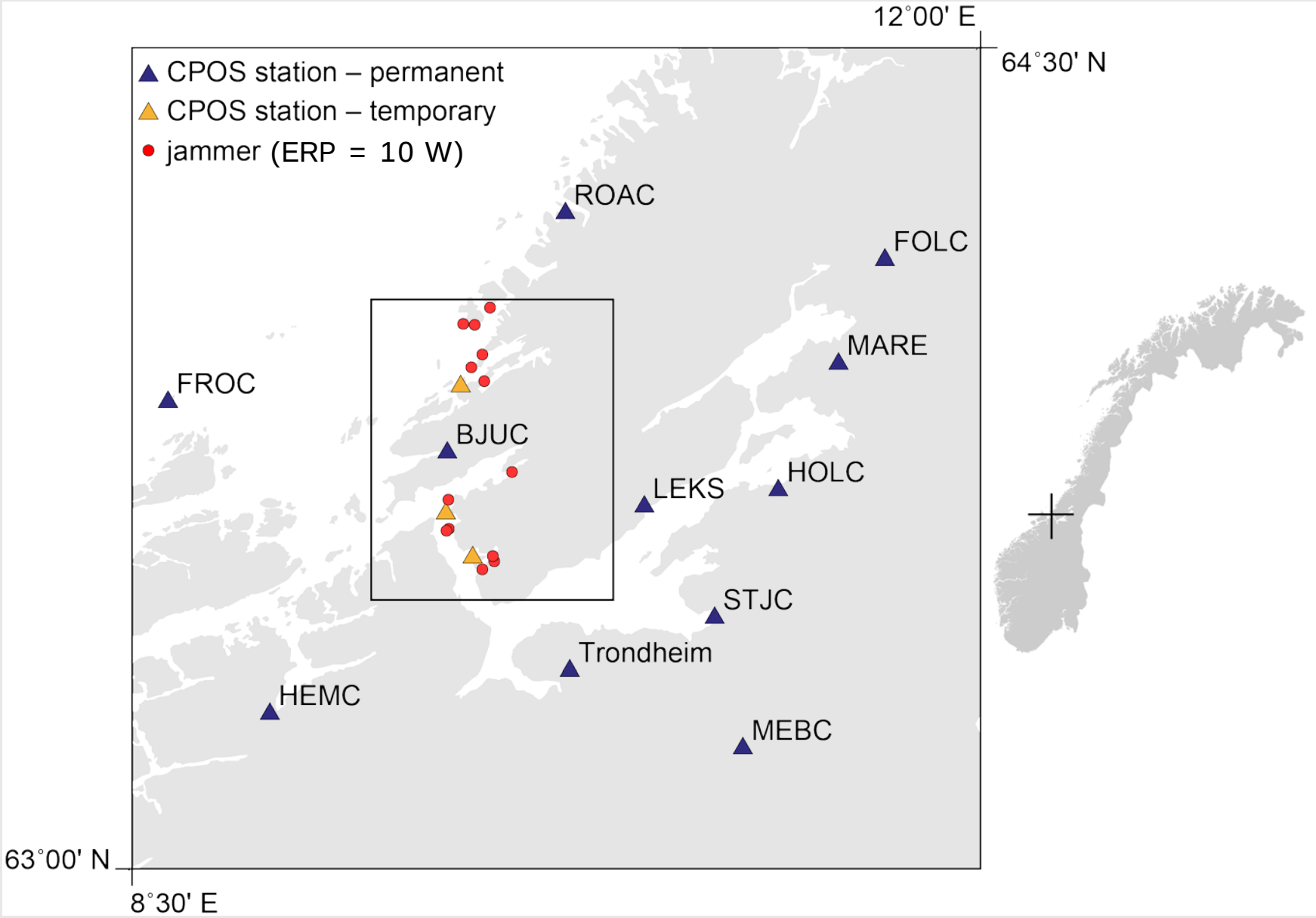
RADIO-FREQUENCY INTERFERENCE (RFI) – WHAT IS IT?

RFI:

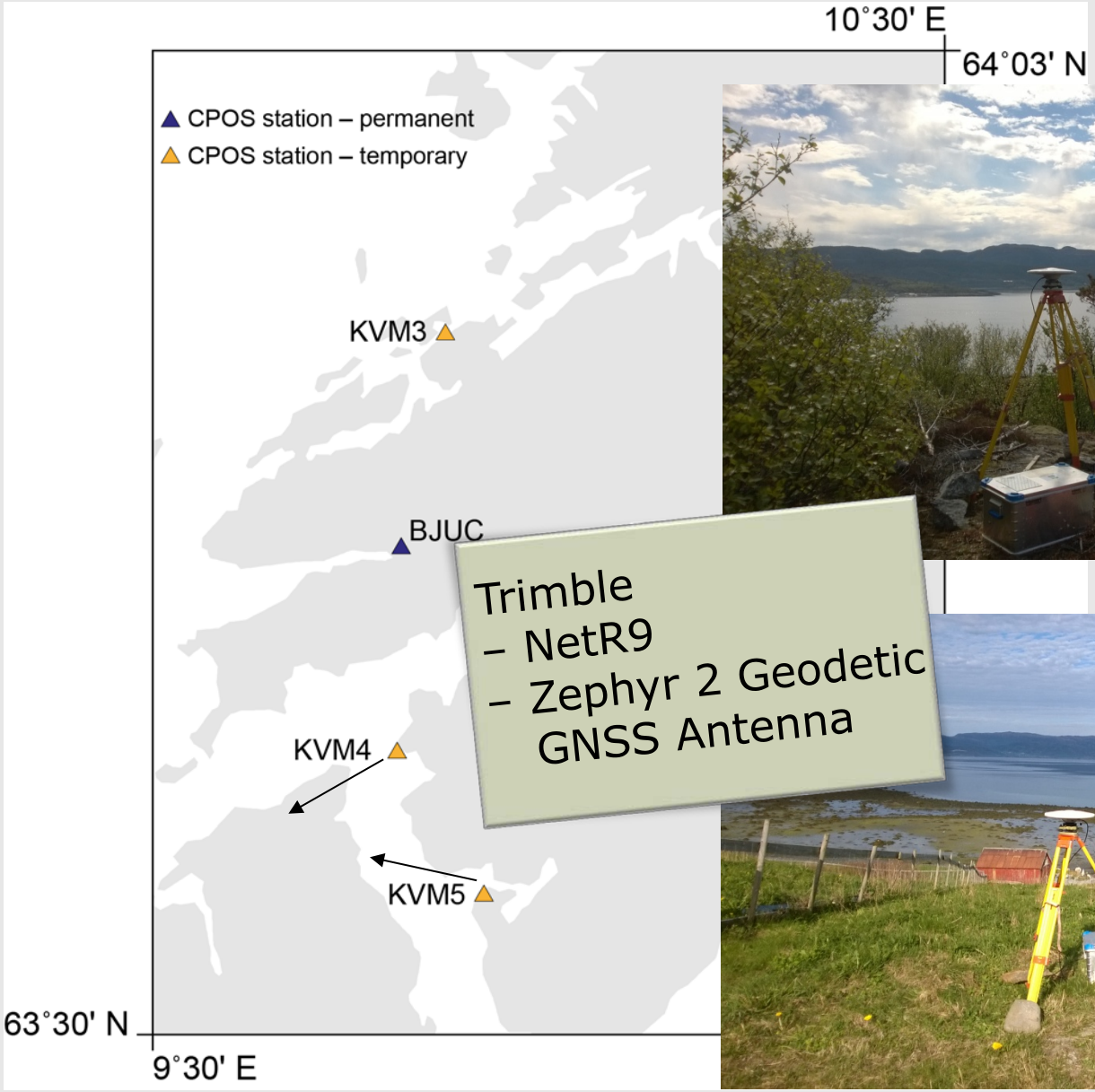
Disorders, generated in the high frequency range and interfere with other devices in their function.



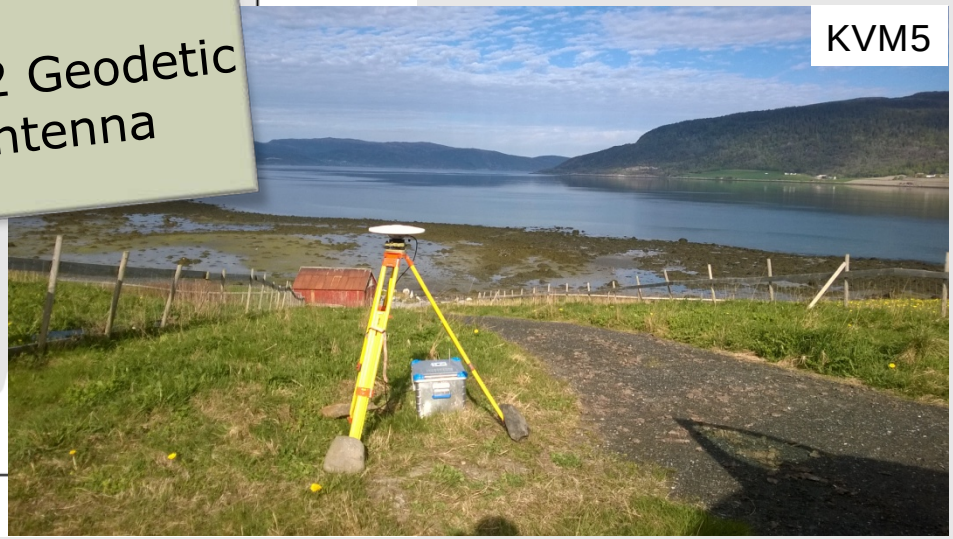
TEST AREA – UNIFIED VISION 2014



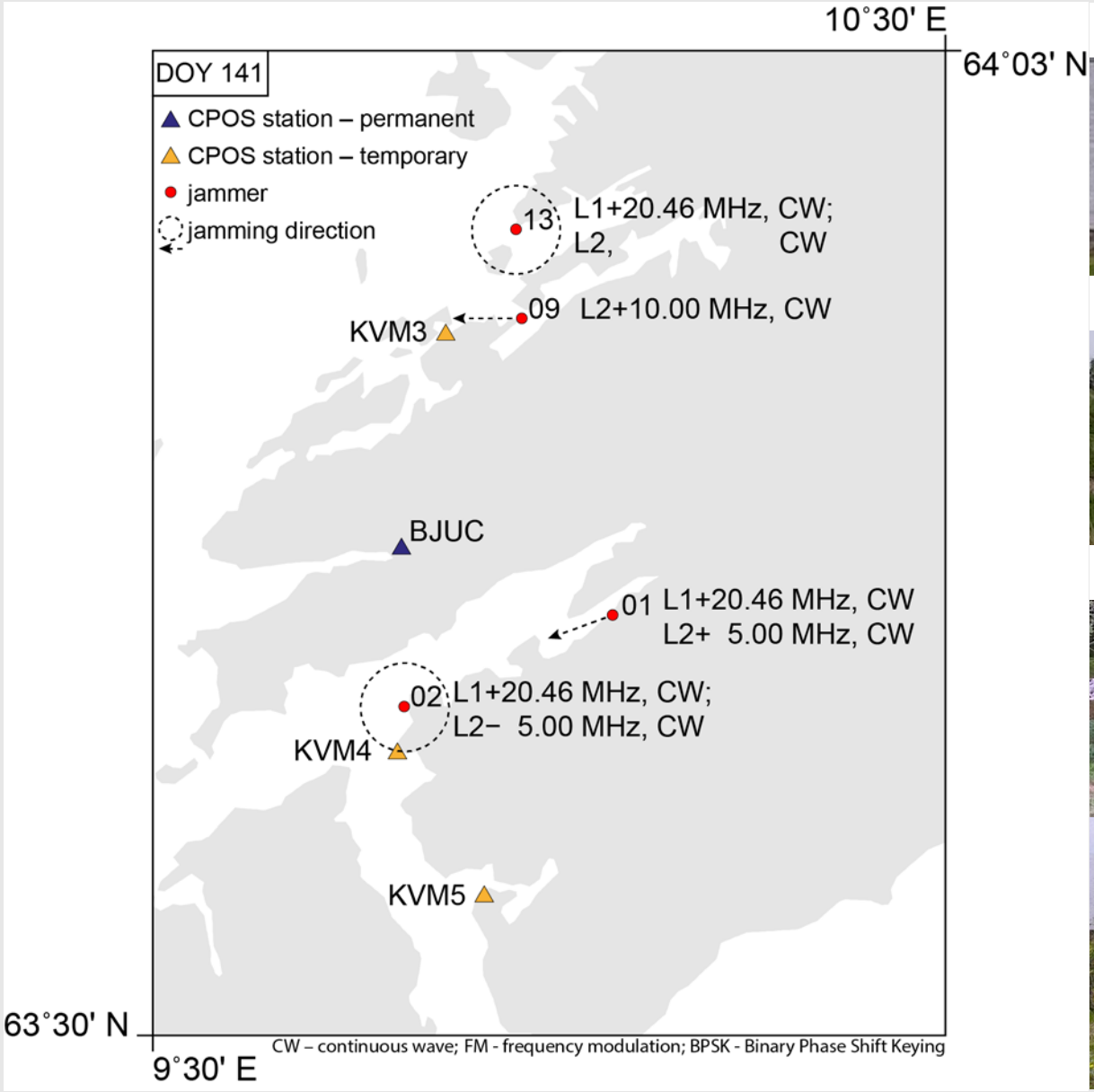
TEST AREA – JAMMING UV14 – #1



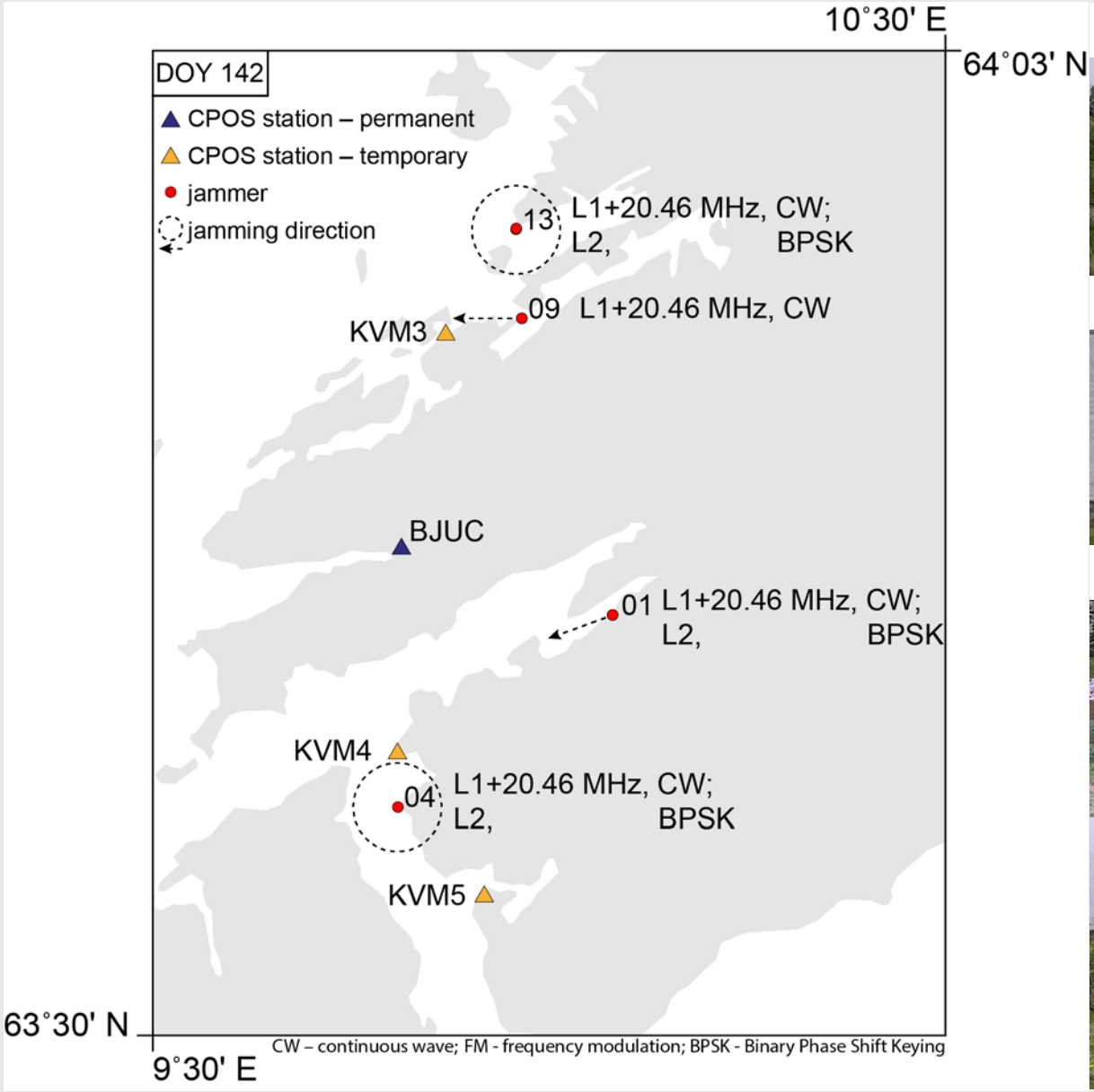
Trimble
– NetR9
– Zephyr 2 Geodetic GNSS Antenna



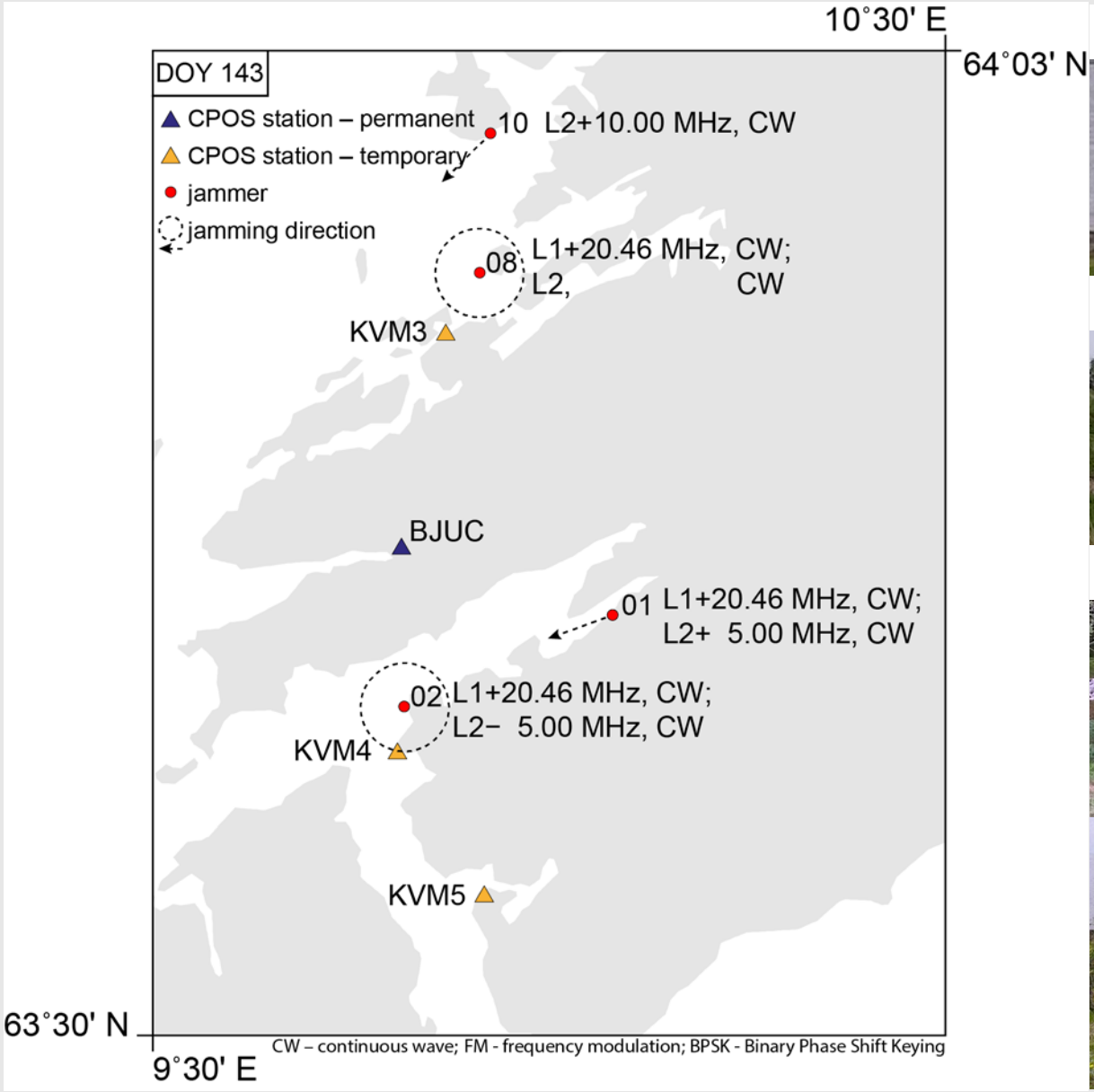
TEST AREA – JAMMING UV14 – #2



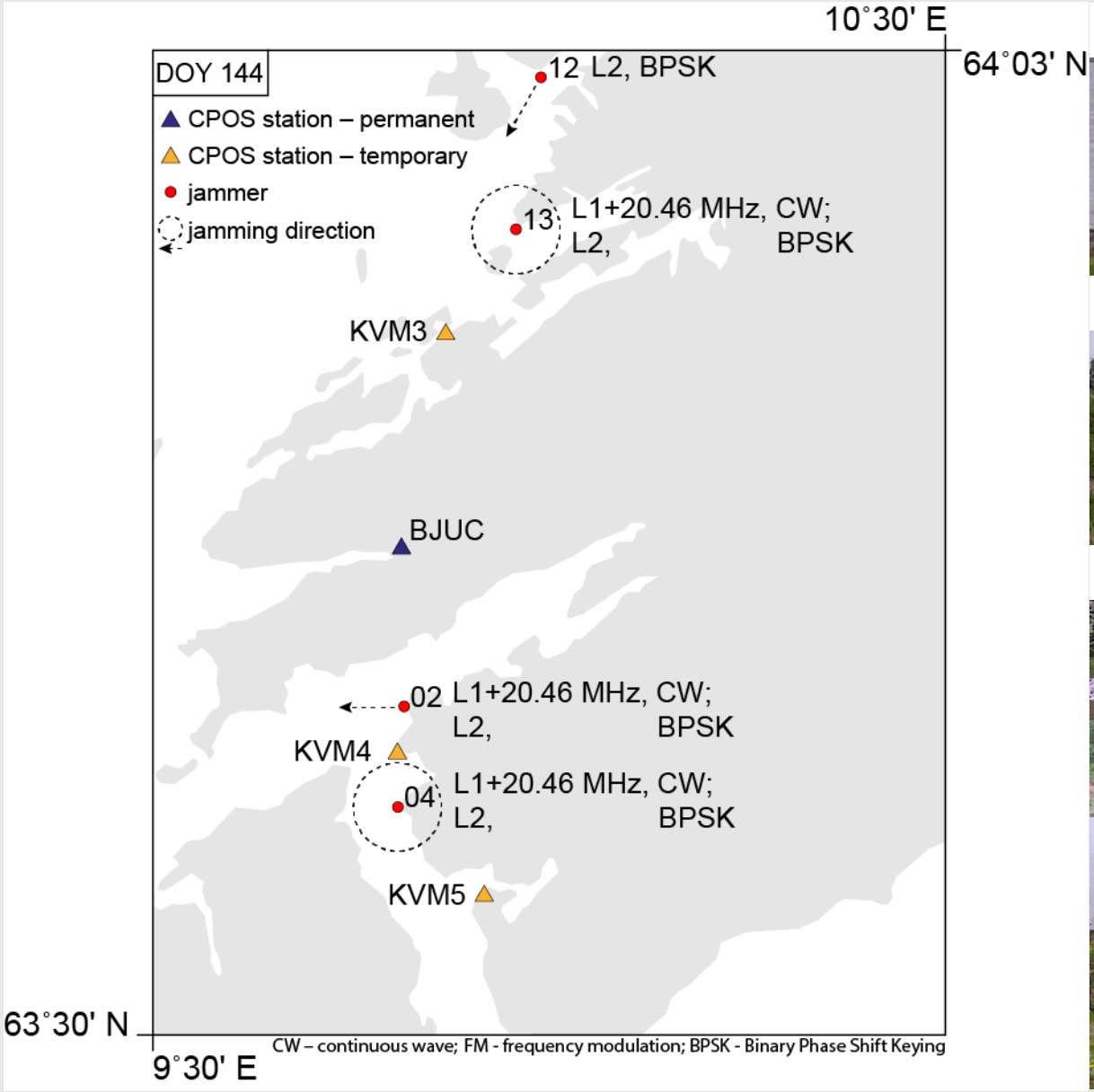
TEST AREA – JAMMING UV14 – #3



TEST AREA – JAMMING UV14 – #4

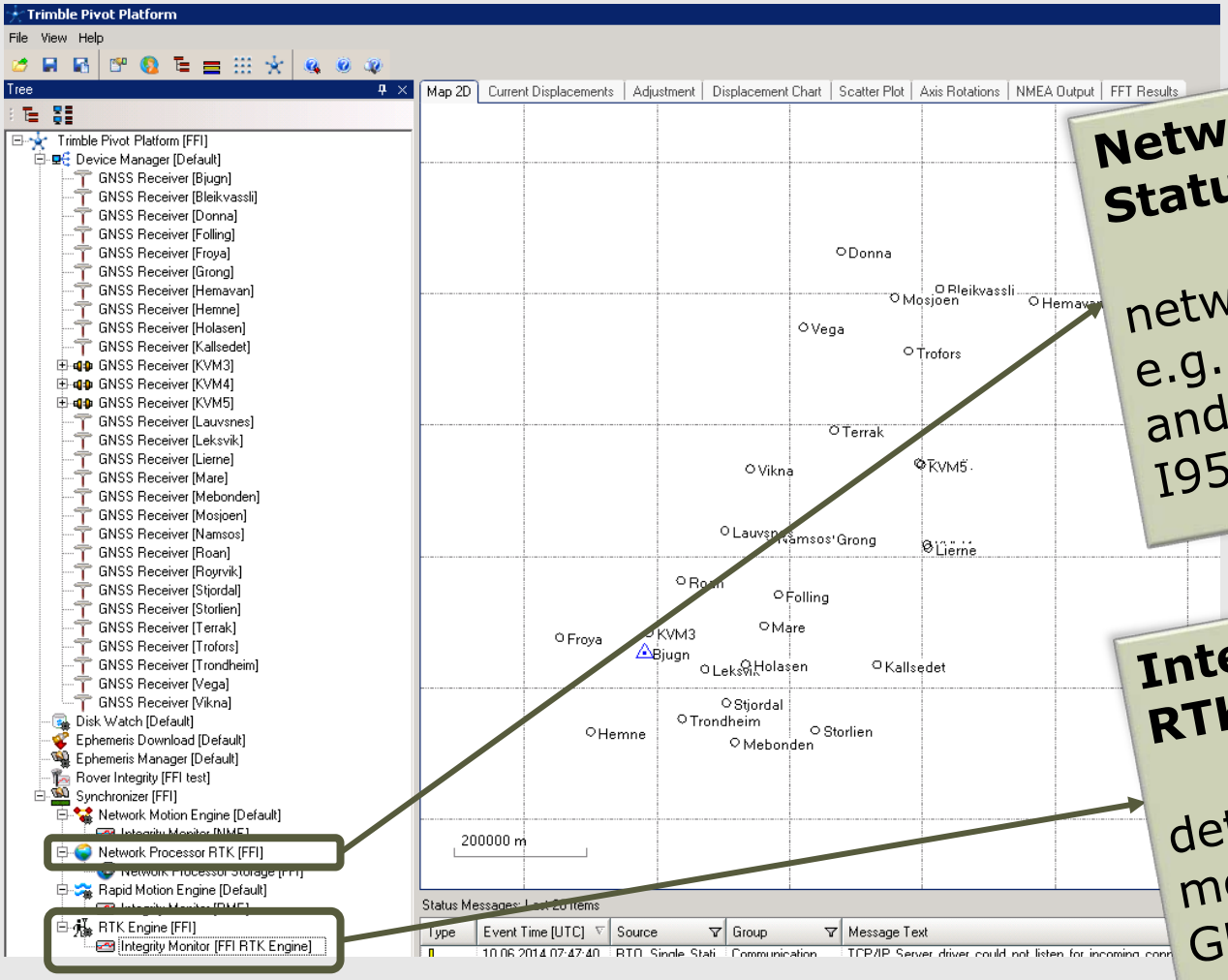


TEST AREA – JAMMING UV14 – #5



TRIMBLE PIVOT PLATFORM V.3.1.3

Network processing of 29 reference stations



Network-Processor Status

network information, e.g. number of tracked and solved satellites, I95-index ...

Integrity Monitor RTK Engine

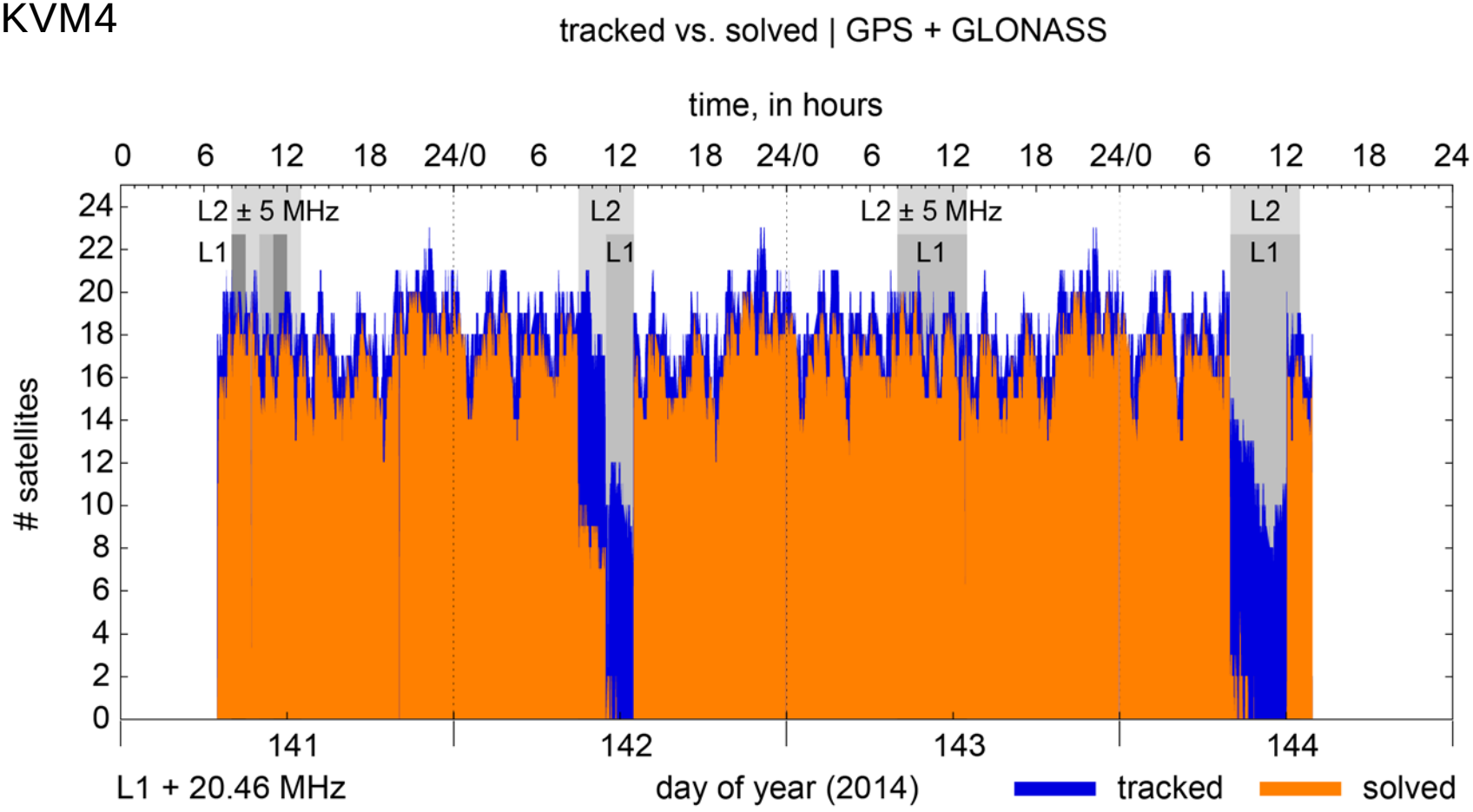
detect significant movement of GNSS station

NETWORK PROCESSOR STATUS #1

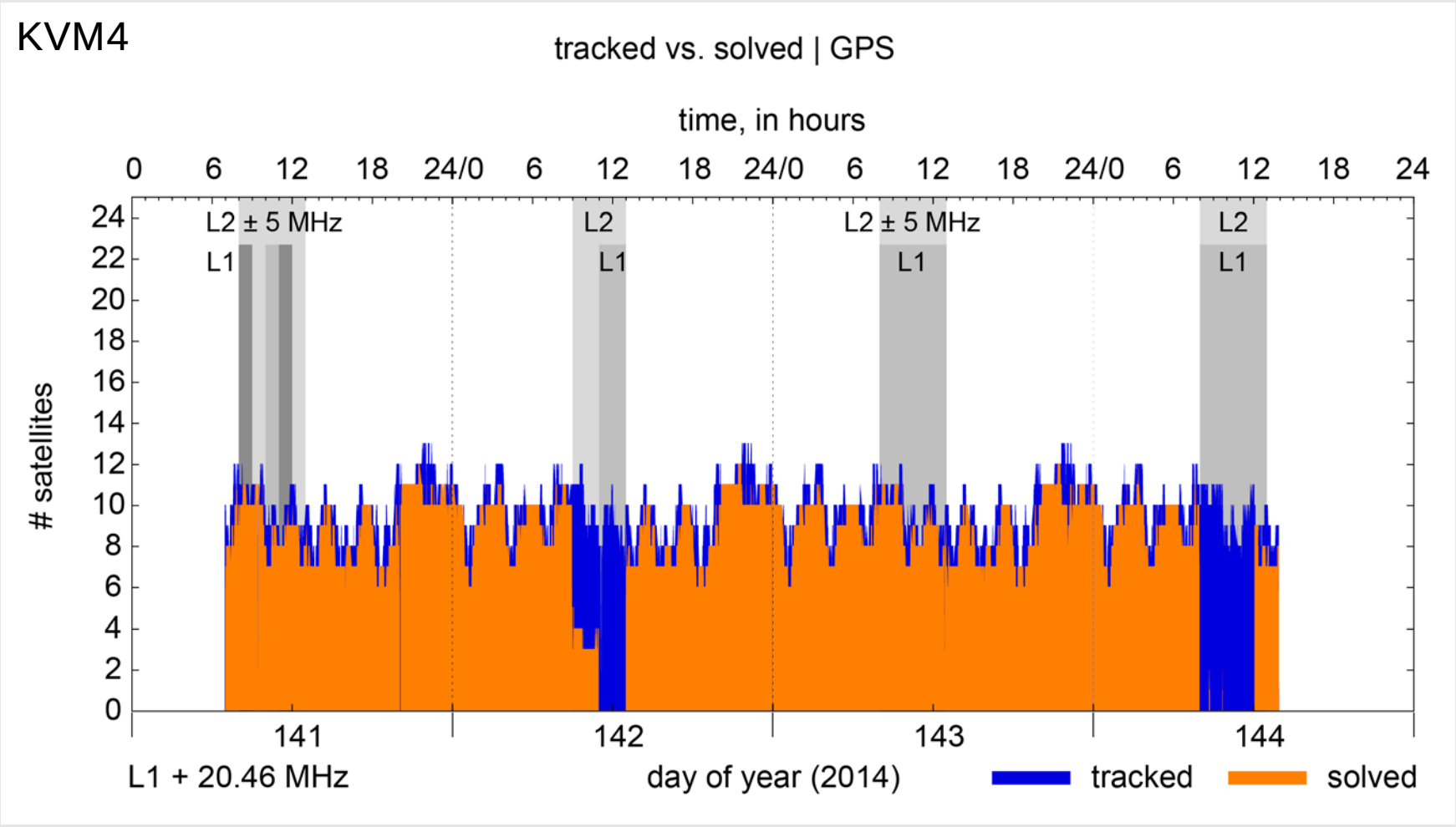
expected vs. observed data

90%	81%	90%	68%

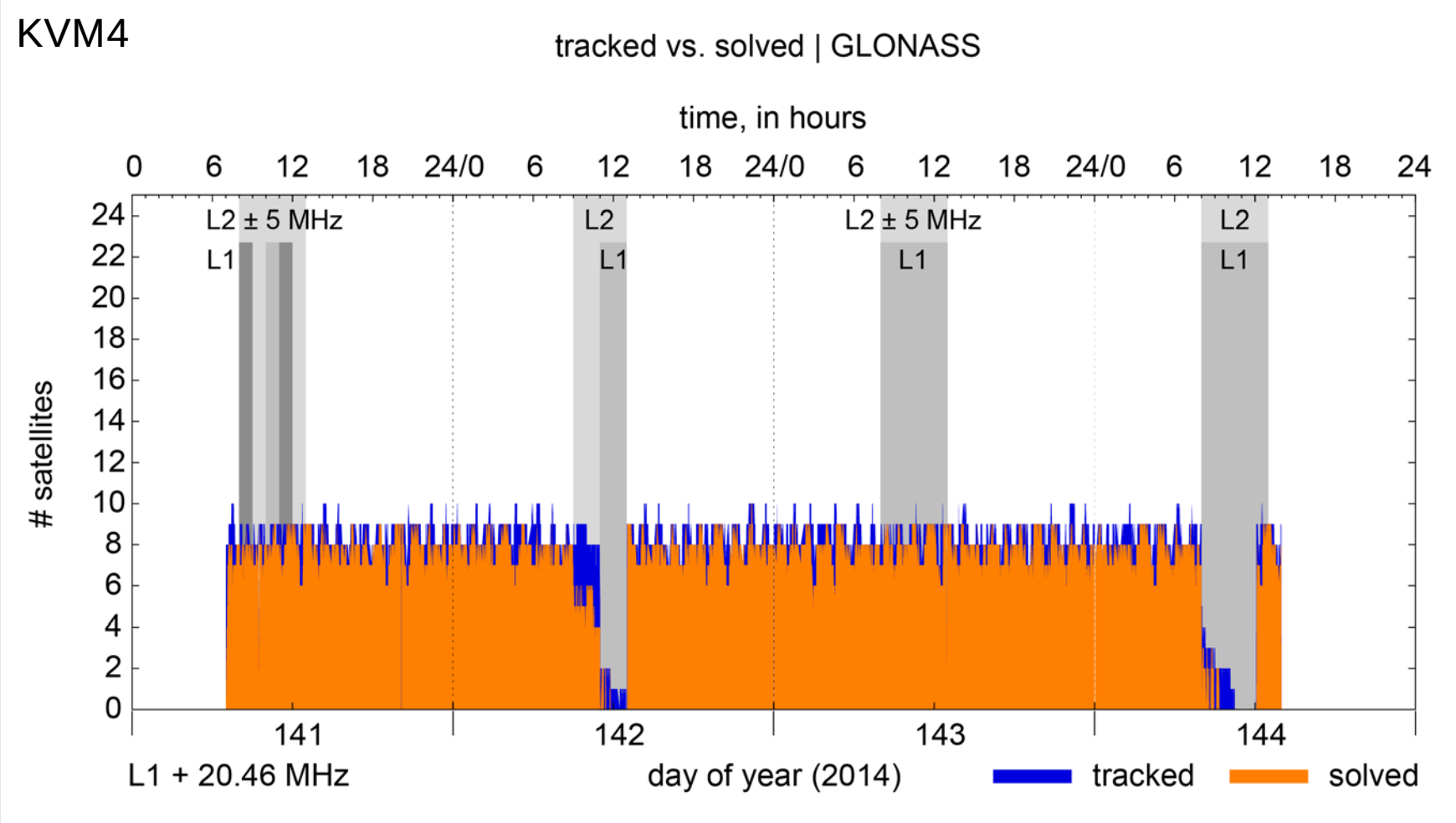
KVM4



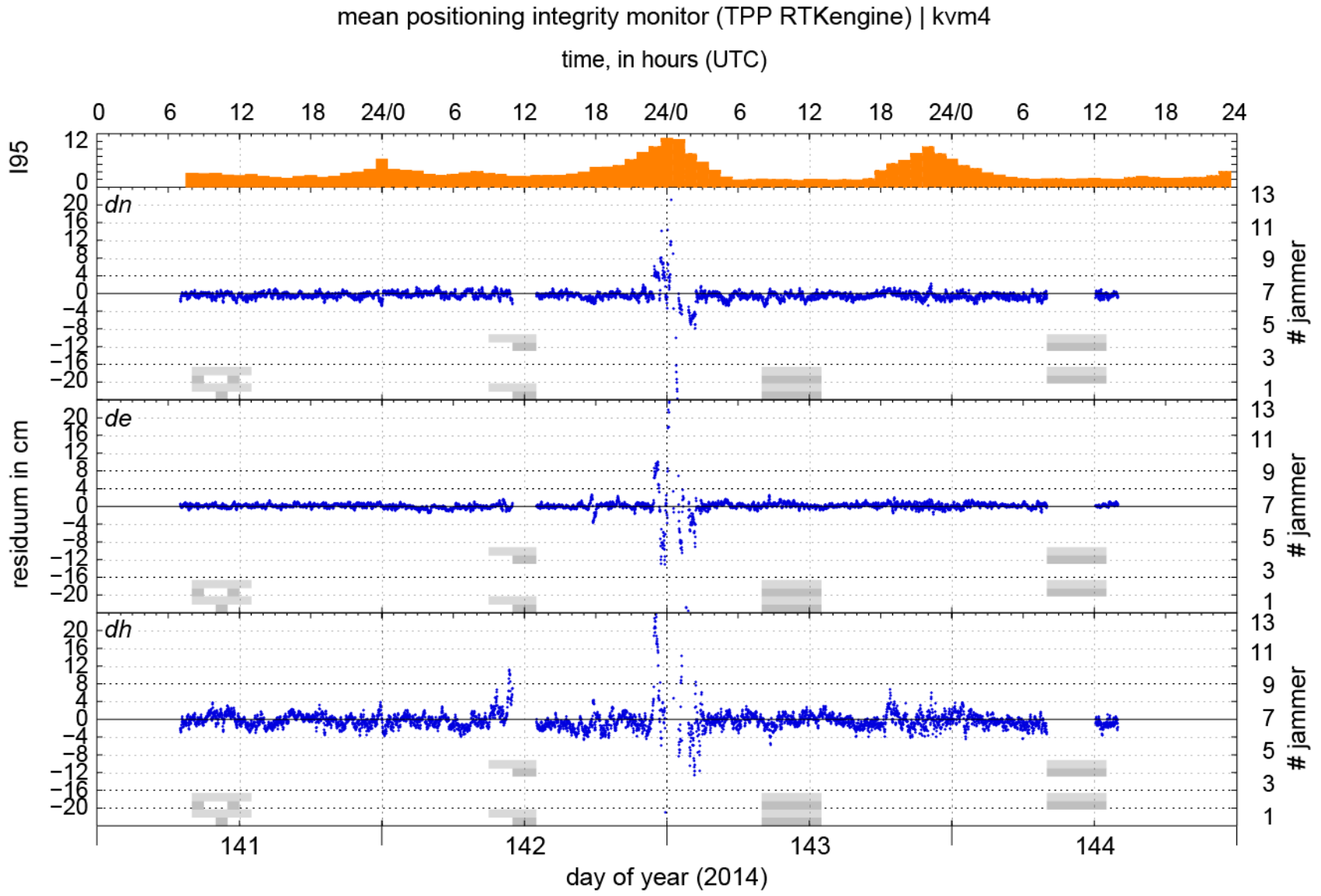
NETWORK PROCESSOR STATUS #2



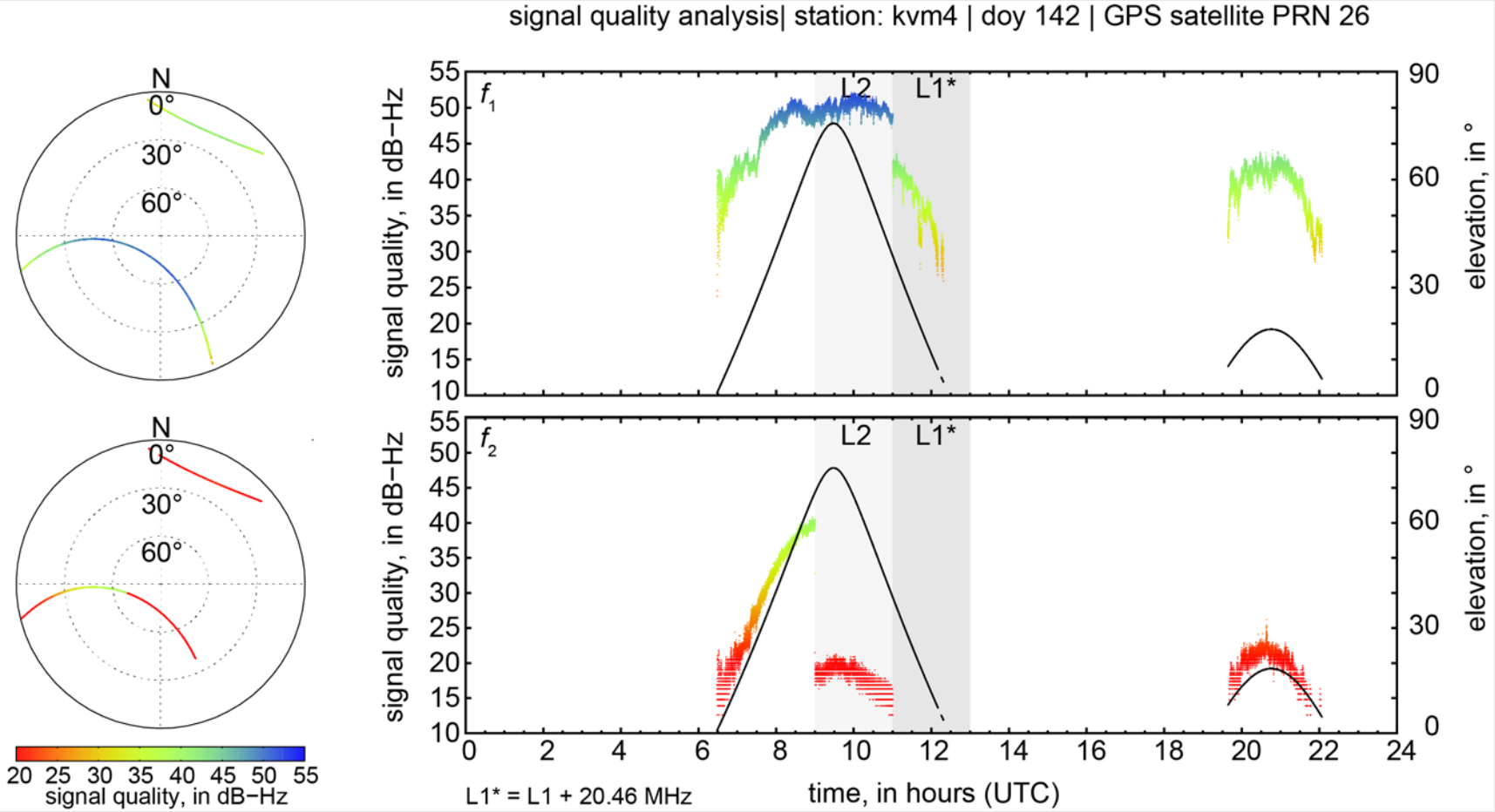
NETWORK PROCESSOR STATUS #3



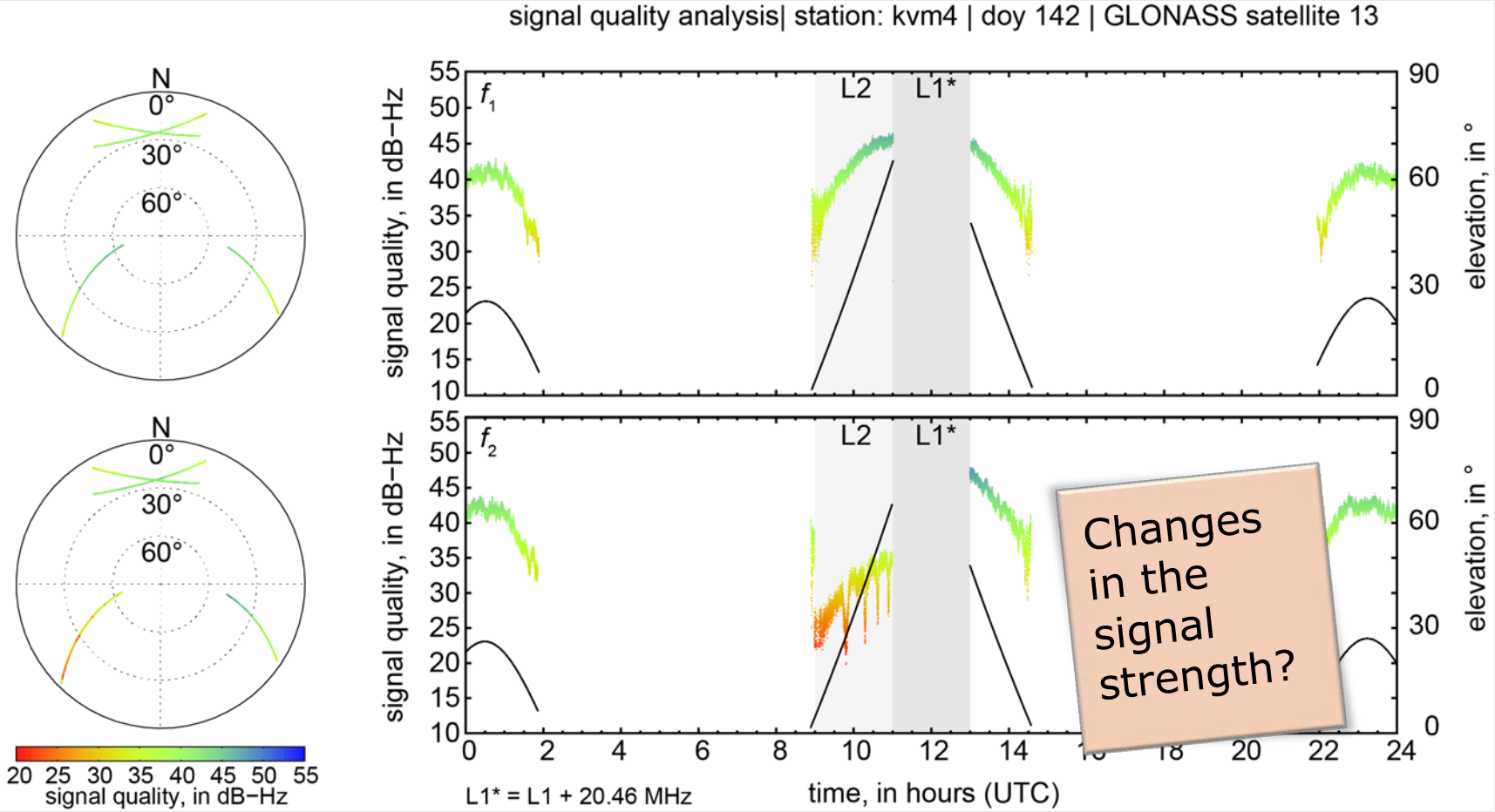
INTEGRITY MONITOR RTK-ENGINE



SIGNAL QUALITY VS. JAMMING #1

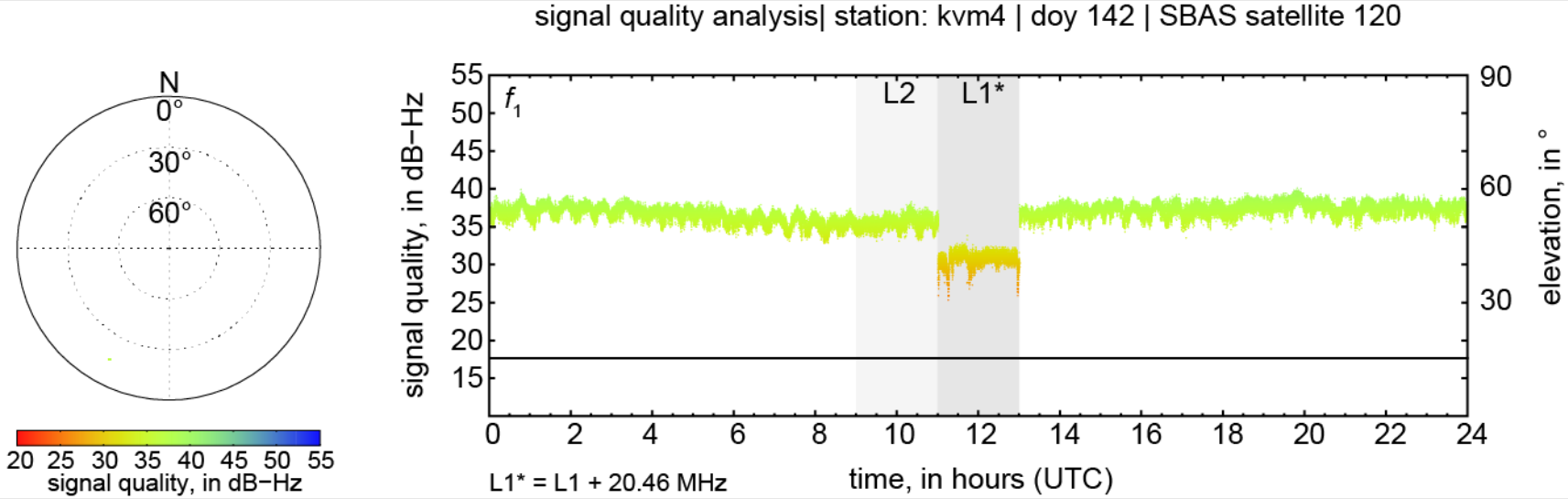


SIGNAL QUALITY VS. JAMMING #2



$f_1 = 1600.8750\ \text{MHz};\ f_2 = 1245.1250\ \text{MHz}$

SIGNAL QUALITY VS. JAMMING #3



CONCLUSION

- threatening effect on the network RTK service performance if the jammer is close and strong enough
- two frequency data are mandatory for network RTK service
- outage of a reference station deteriorates e.g. the quality of virtual reference station (VRS) data
- receiver performance degradation if jamming occurs

frequency diversity

dense station network

hardening GPS receivers and antennas

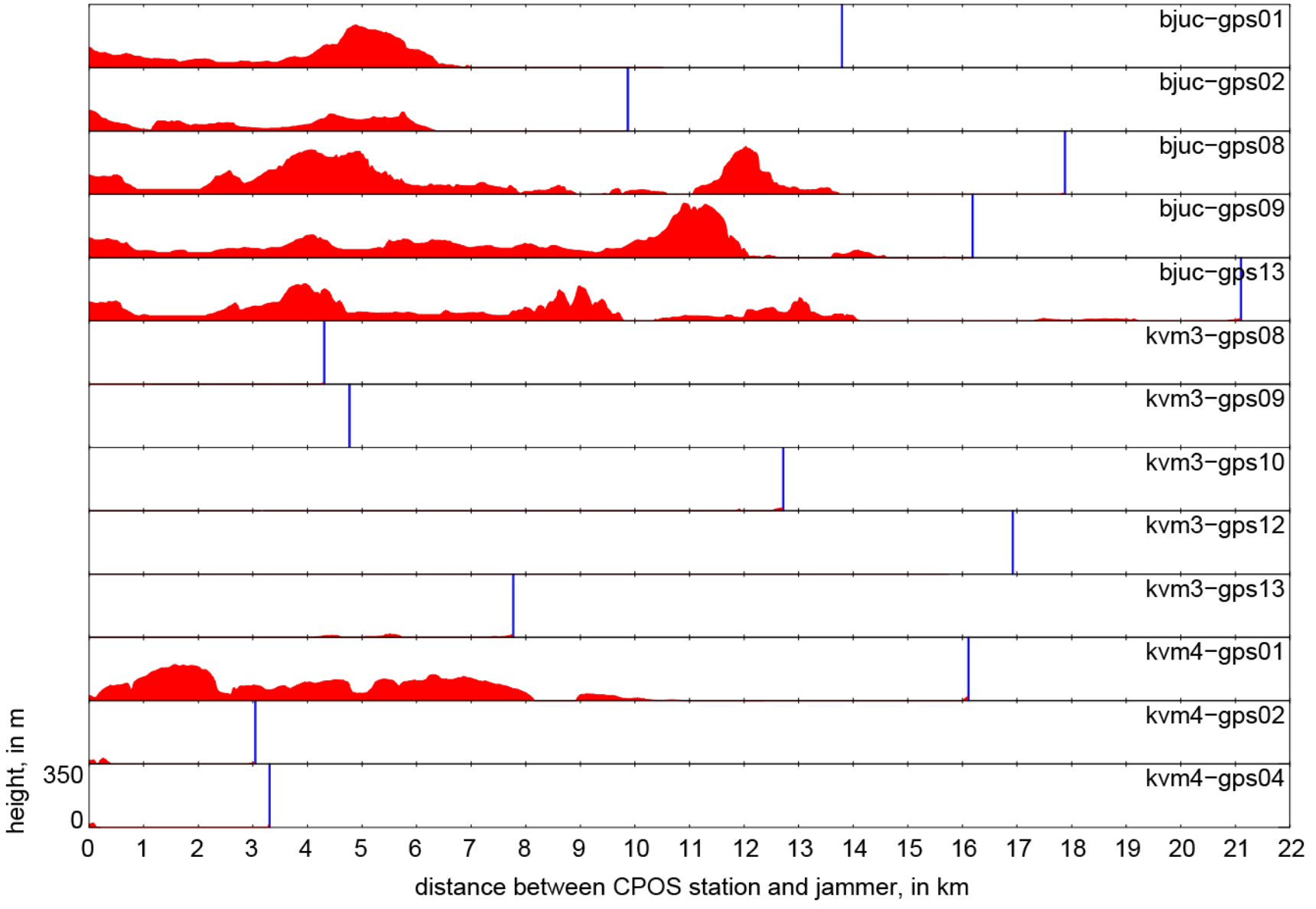
establishing GNSS backups

Questions?

Comments?

APPENDIX

HEIGHT PROFILE

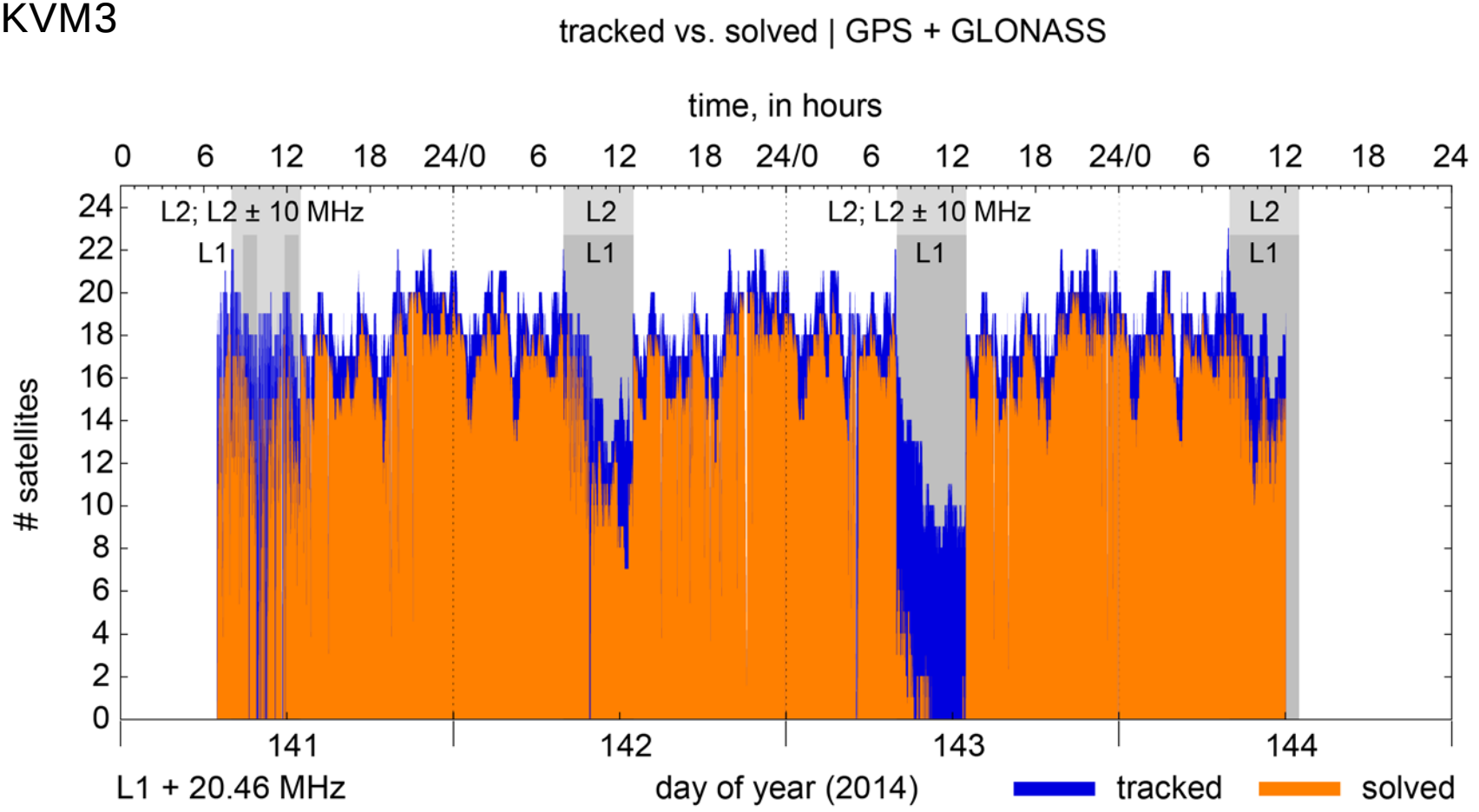


NETWORK PROCESSOR STATUS #4

expected vs. observed data

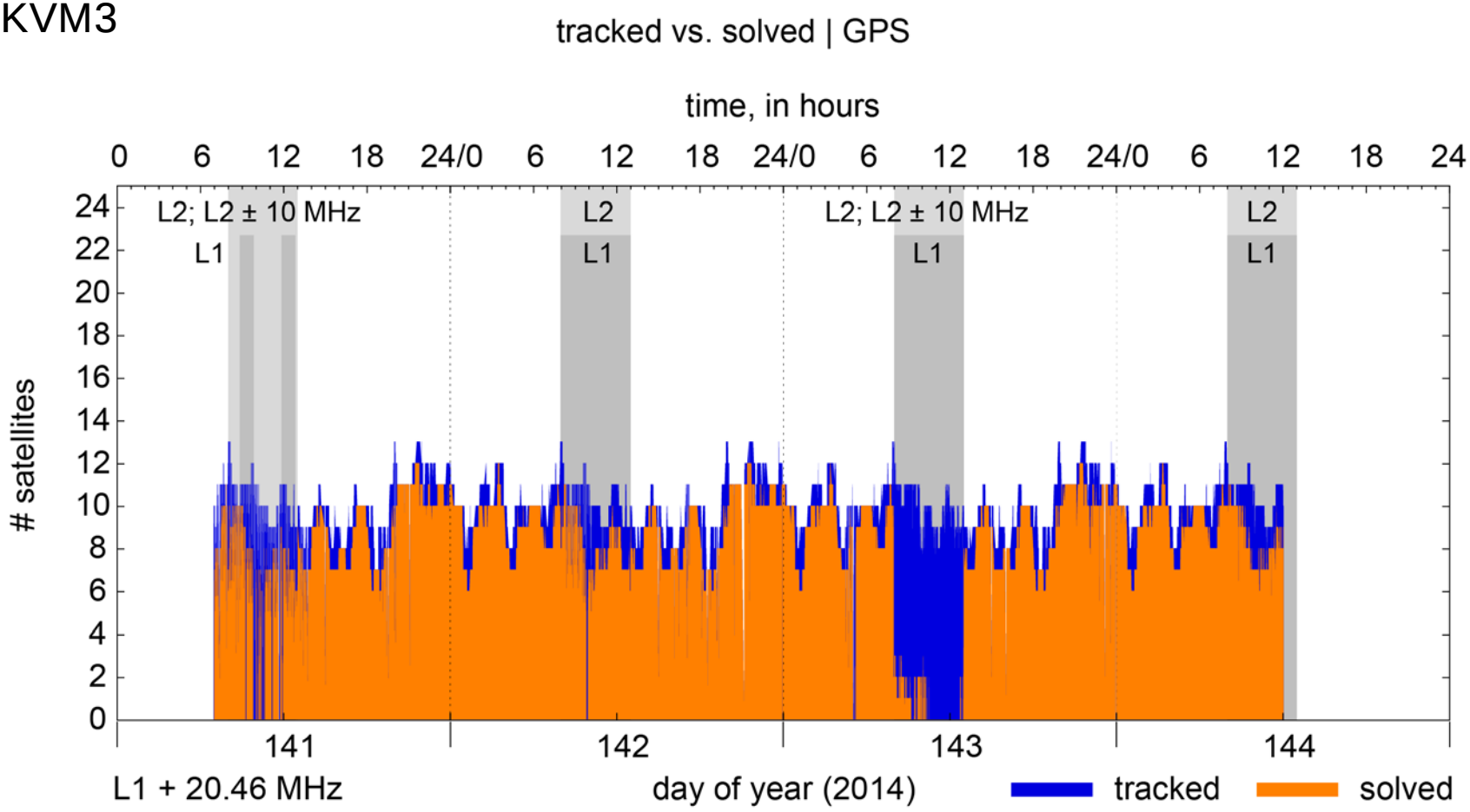
90%	88%	78%	88%

KVM3



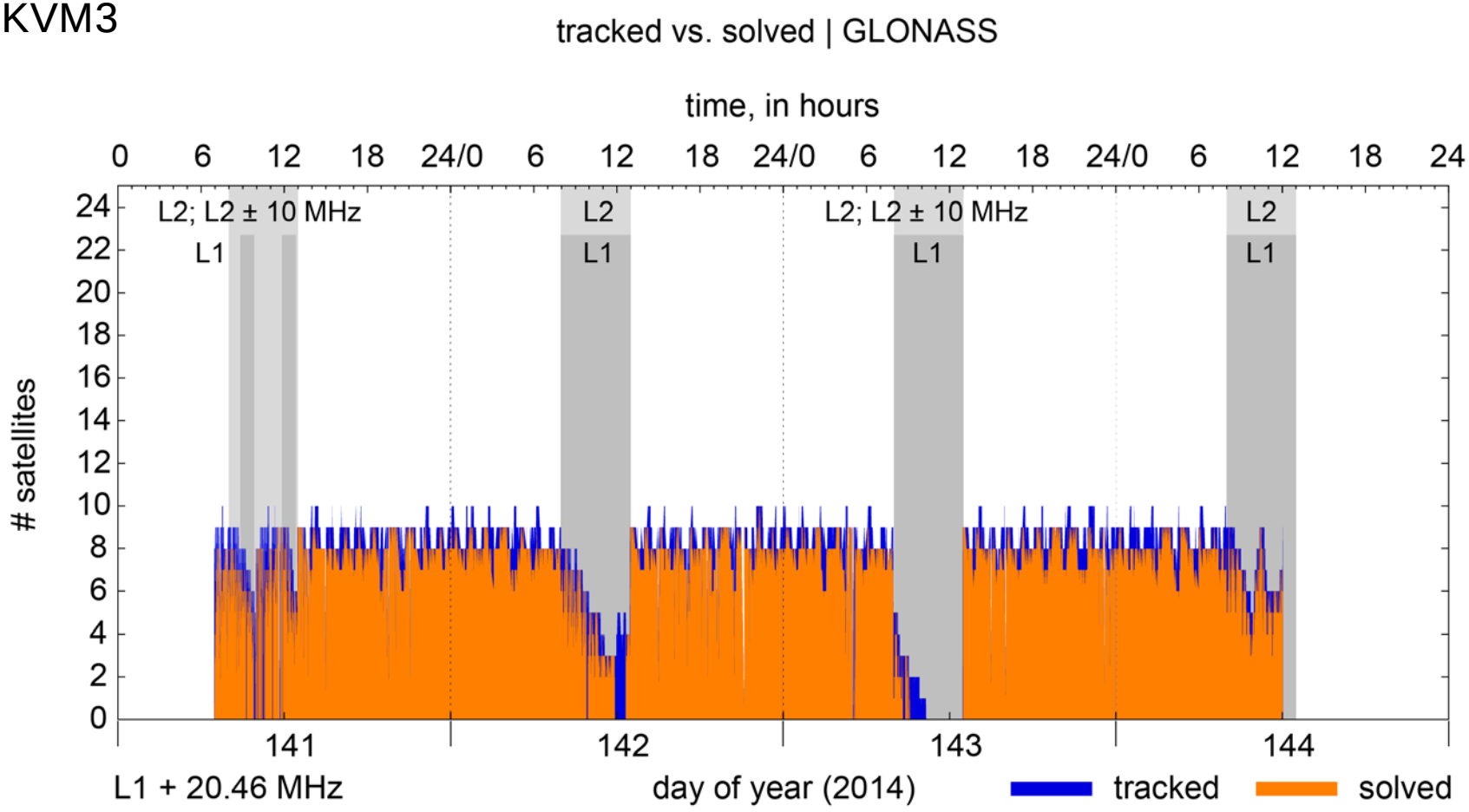
NETWORK PROCESSOR STATUS #5

KVM3



NETWORK PROCESSOR STATUS #6

KVM3



INTEGRITY MONITOR RTK-ENGINE