Ultra-rapids and ultra-rapid predictions for GPS

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Introduction

GOP - Geodetic observatory Pecný of the RIGTC (Czech Rep)

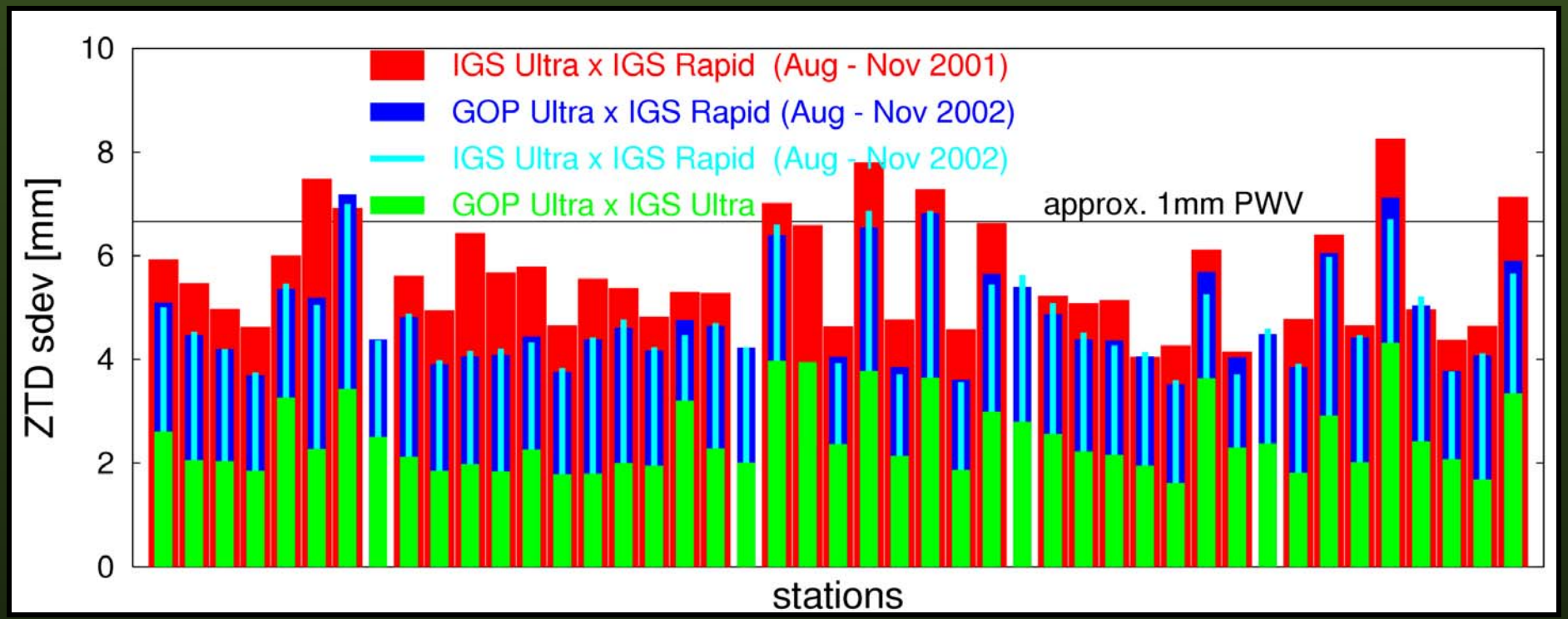
- → from 1999 developing the NRT GPS analysis
- → from 2000 contributing to European ground-based GPS meteorology (within COST-716, TOUGH projects)
- → from January 2004, contributing to IGS with ultra-rapid orbits

Content

- Motivation from the application example
- Role of the ultra-rapids within the precise orbit products
- Introduce the orbit determination in GOP
- Summary

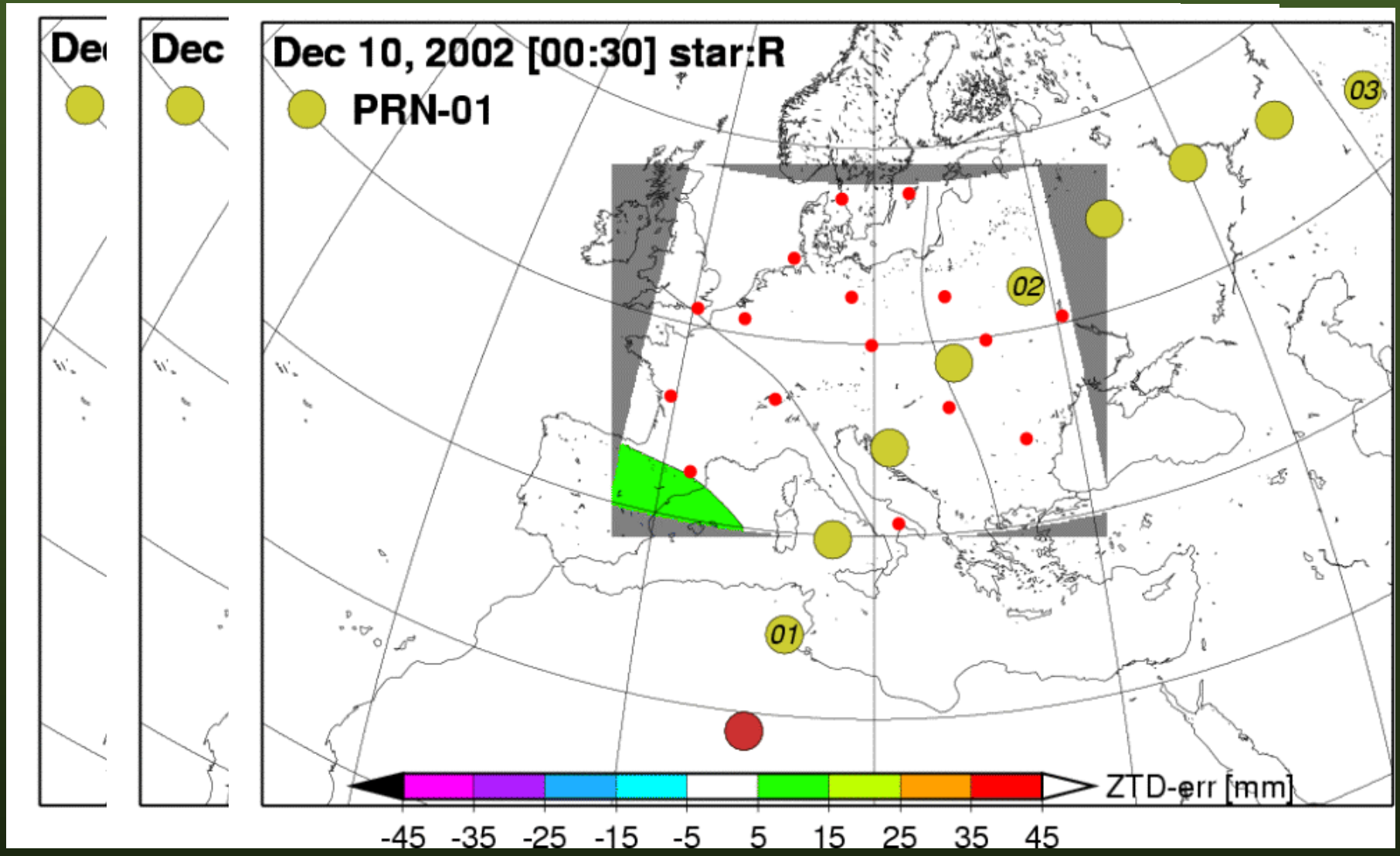
Application of IGU (& GOP) orbits
to GPS meteorology (a driving motivation)

- ZTD results using IGU during identical 3-months in 2001 & 2002
- ZTD results using IGU & GOP during the COST-716 campaign

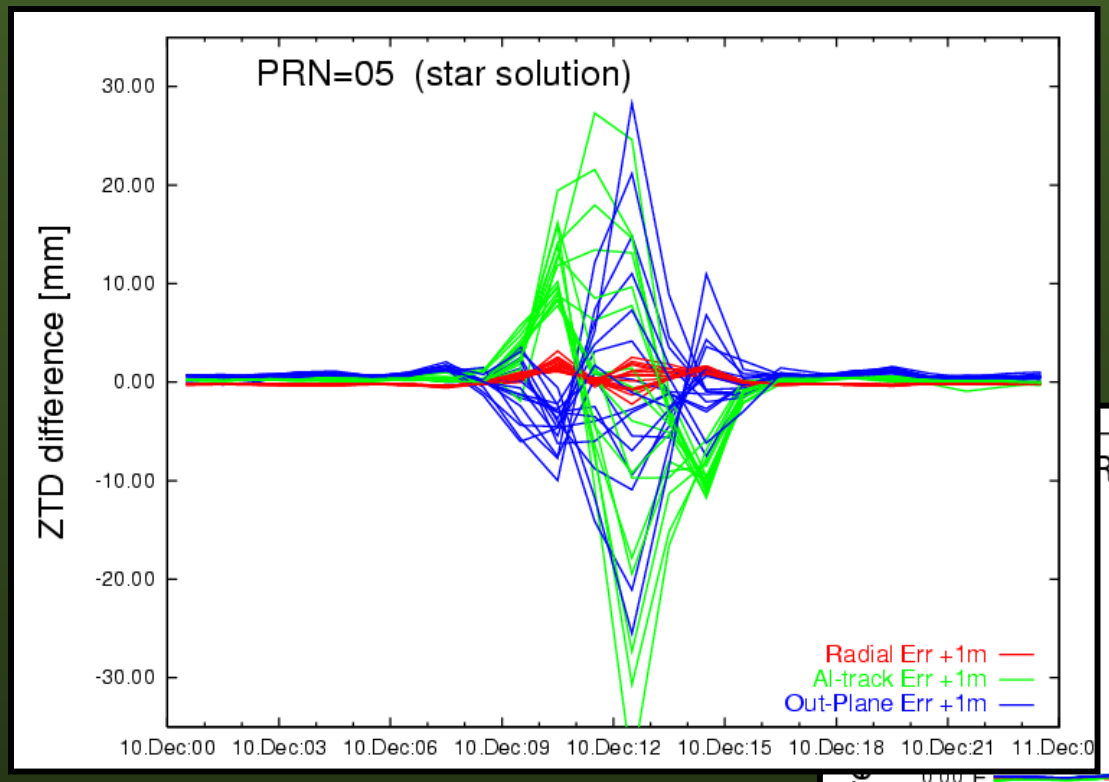


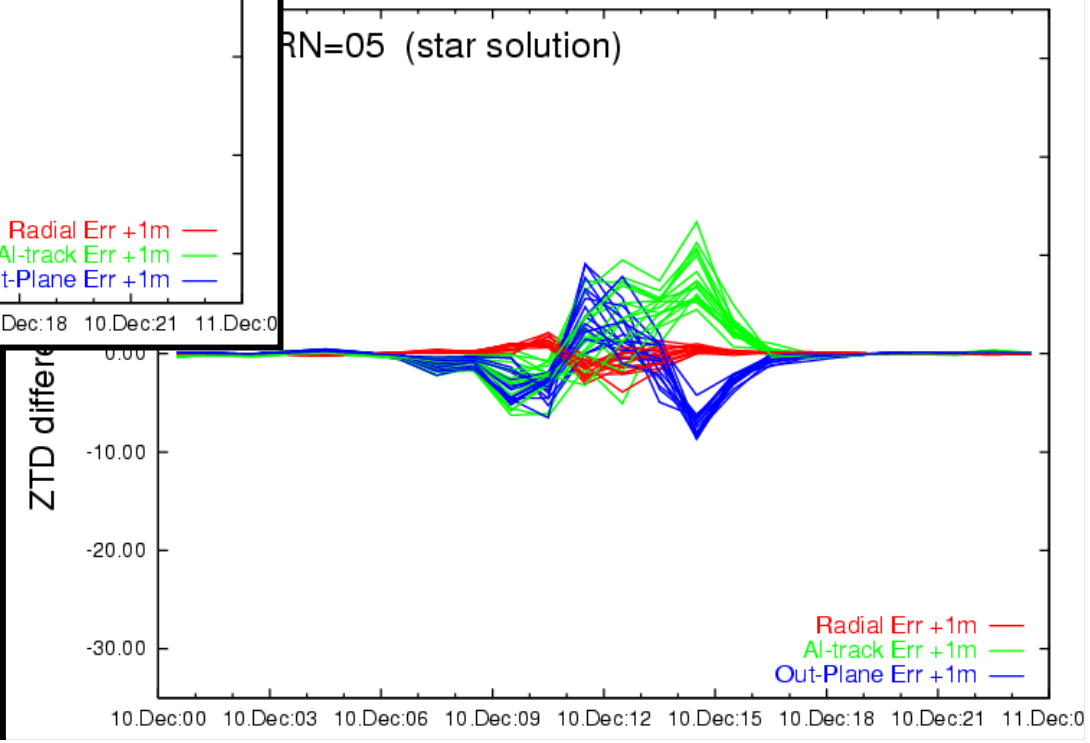
Simulated effect of orbit errors on ZTD

(network solution)

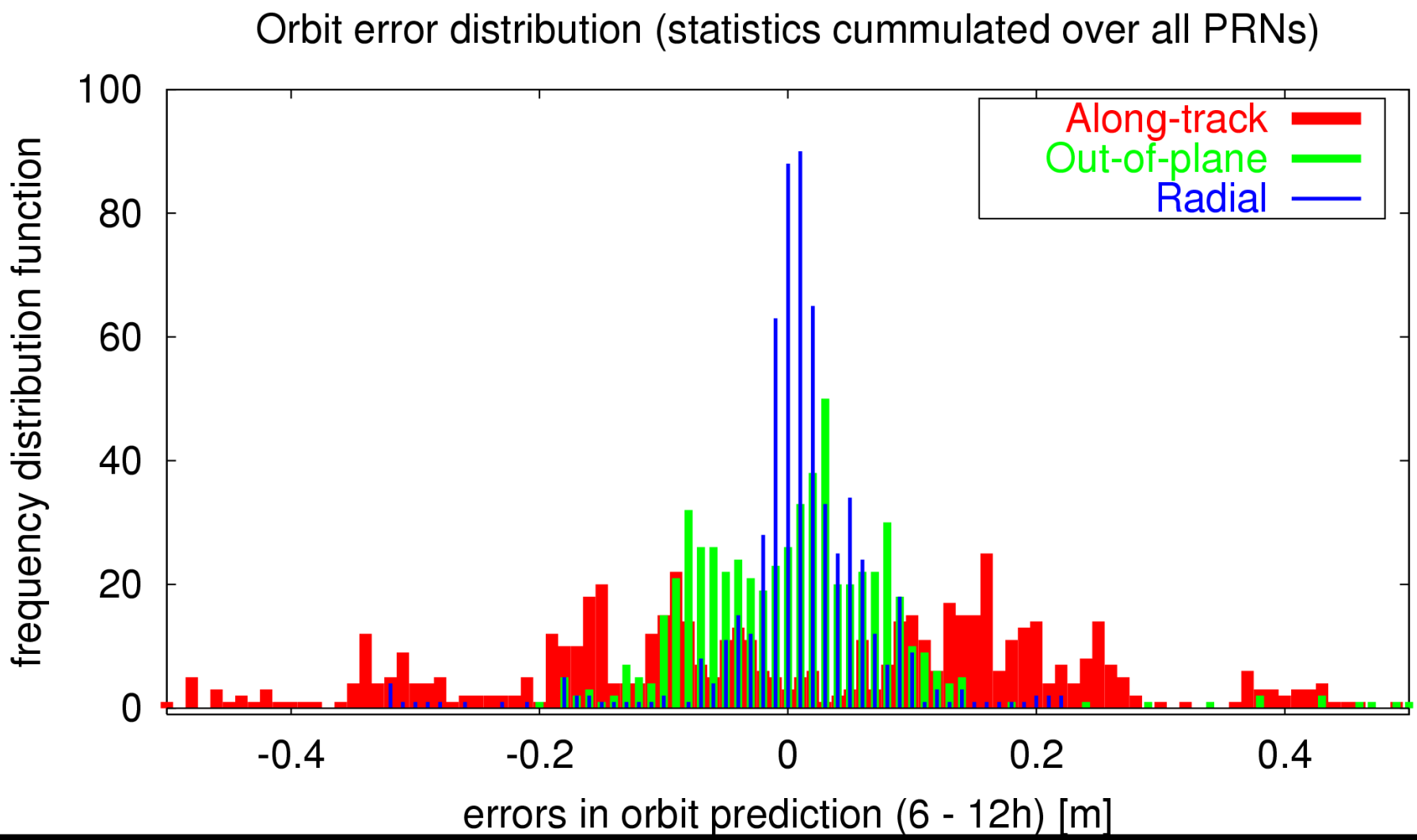


Effect of systematic orbit error (cont'd)

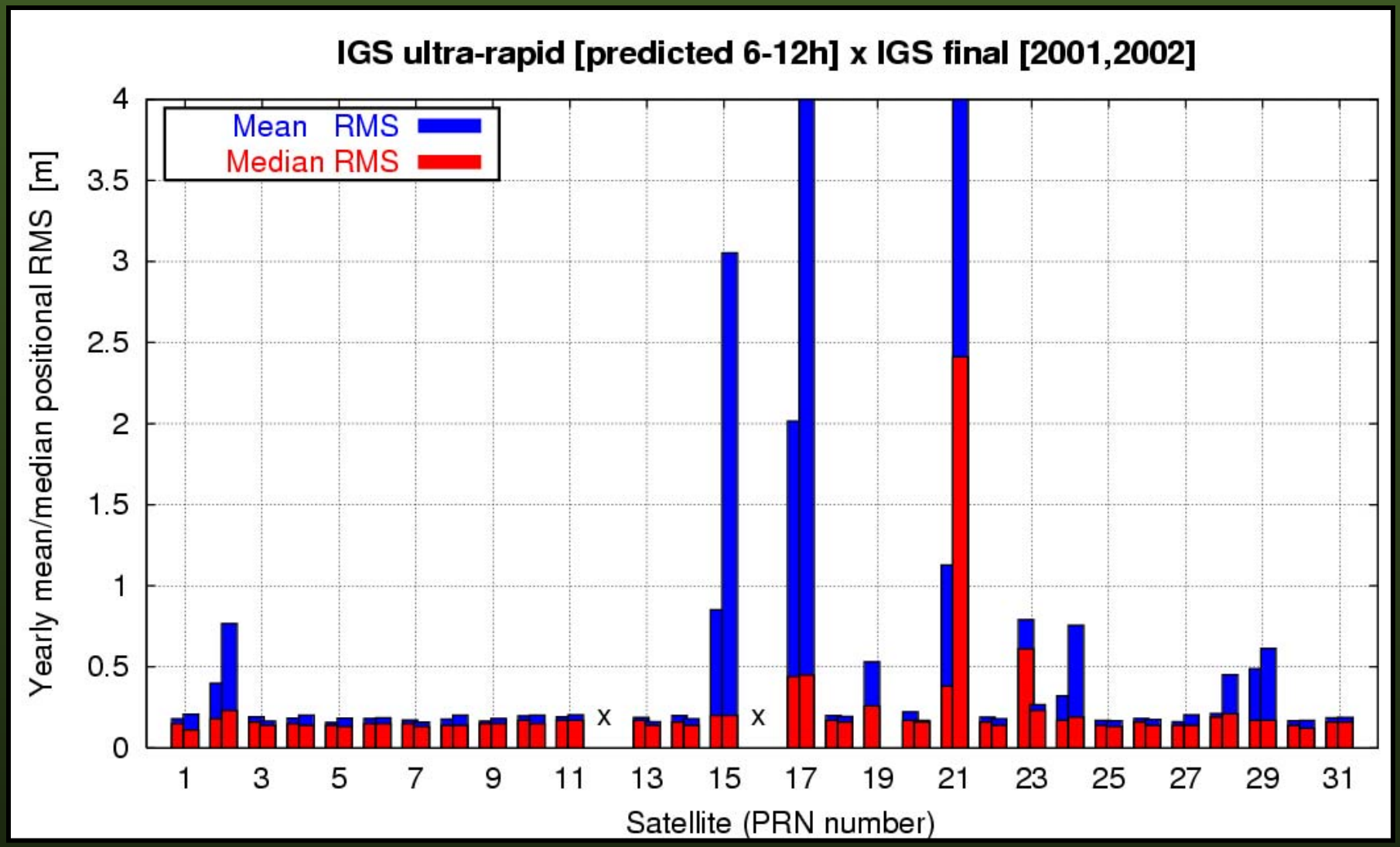




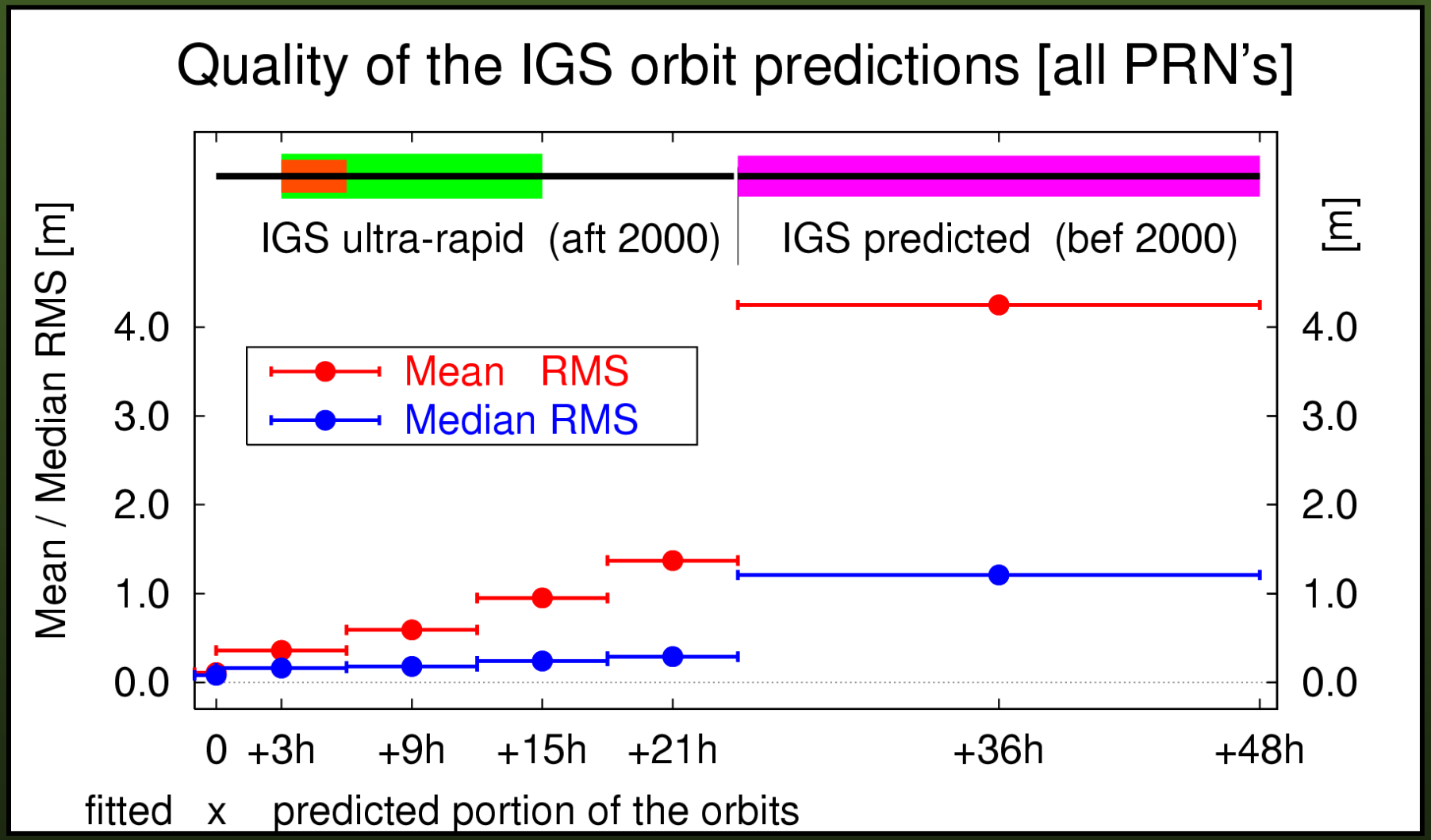
Error distribution of the ultra-rapid orbits



Satellite orbit quality & missing satellites

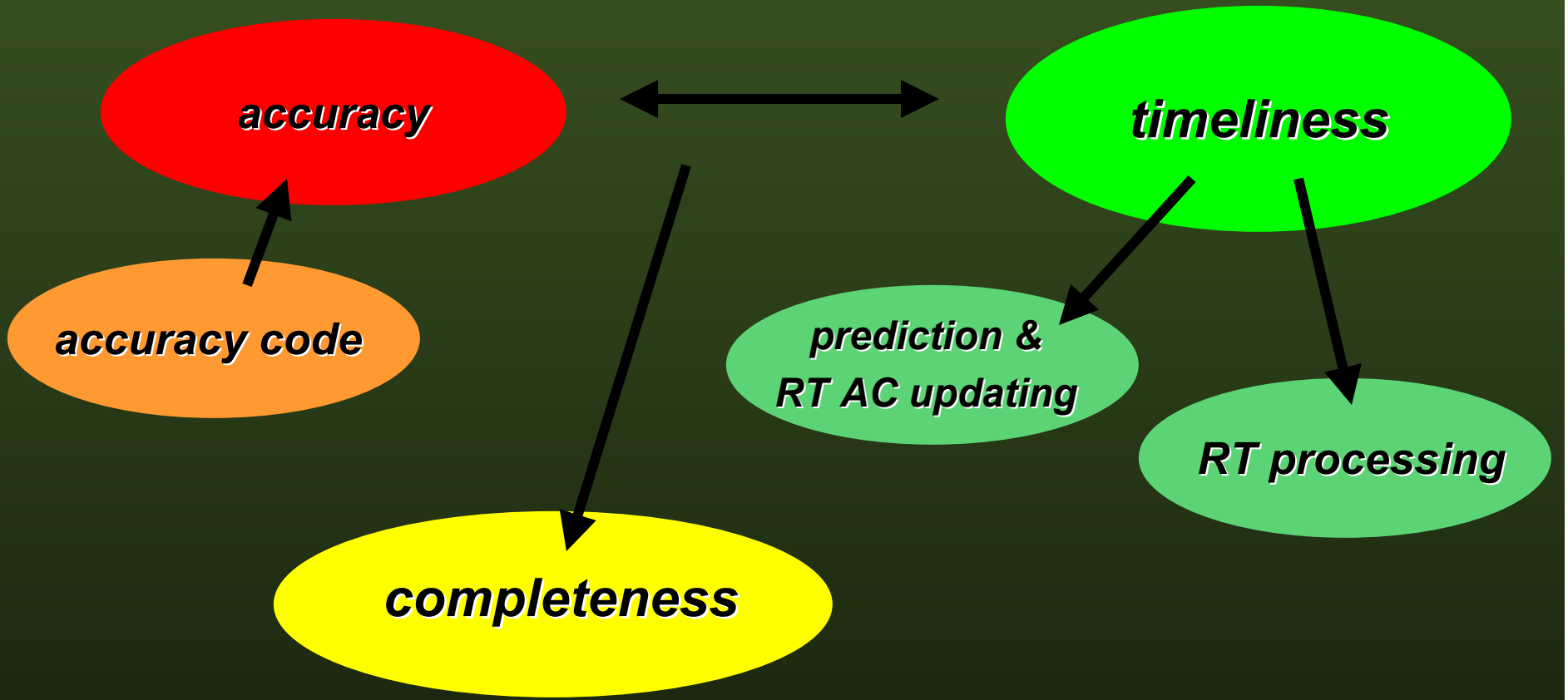


Precise orbit quality



Application demands

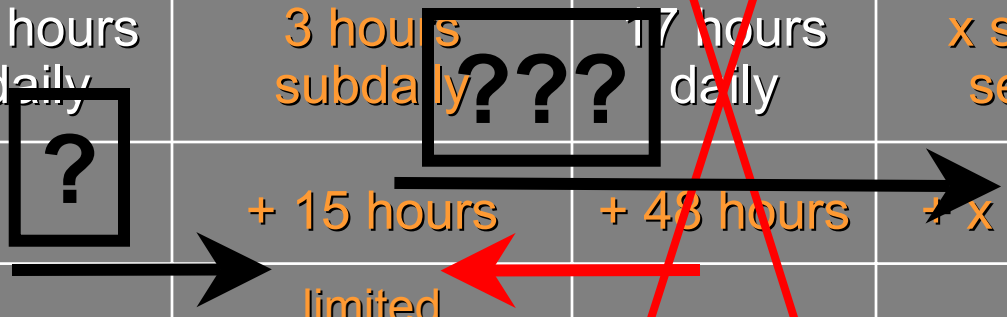
FINALS -- RAPIDS -- ULTRA-RAPIDS -- REAL-TIME



Role of the ultra-rapids in other

→ *post-processing features (accuracy)* → *real-time features (timeliness)*

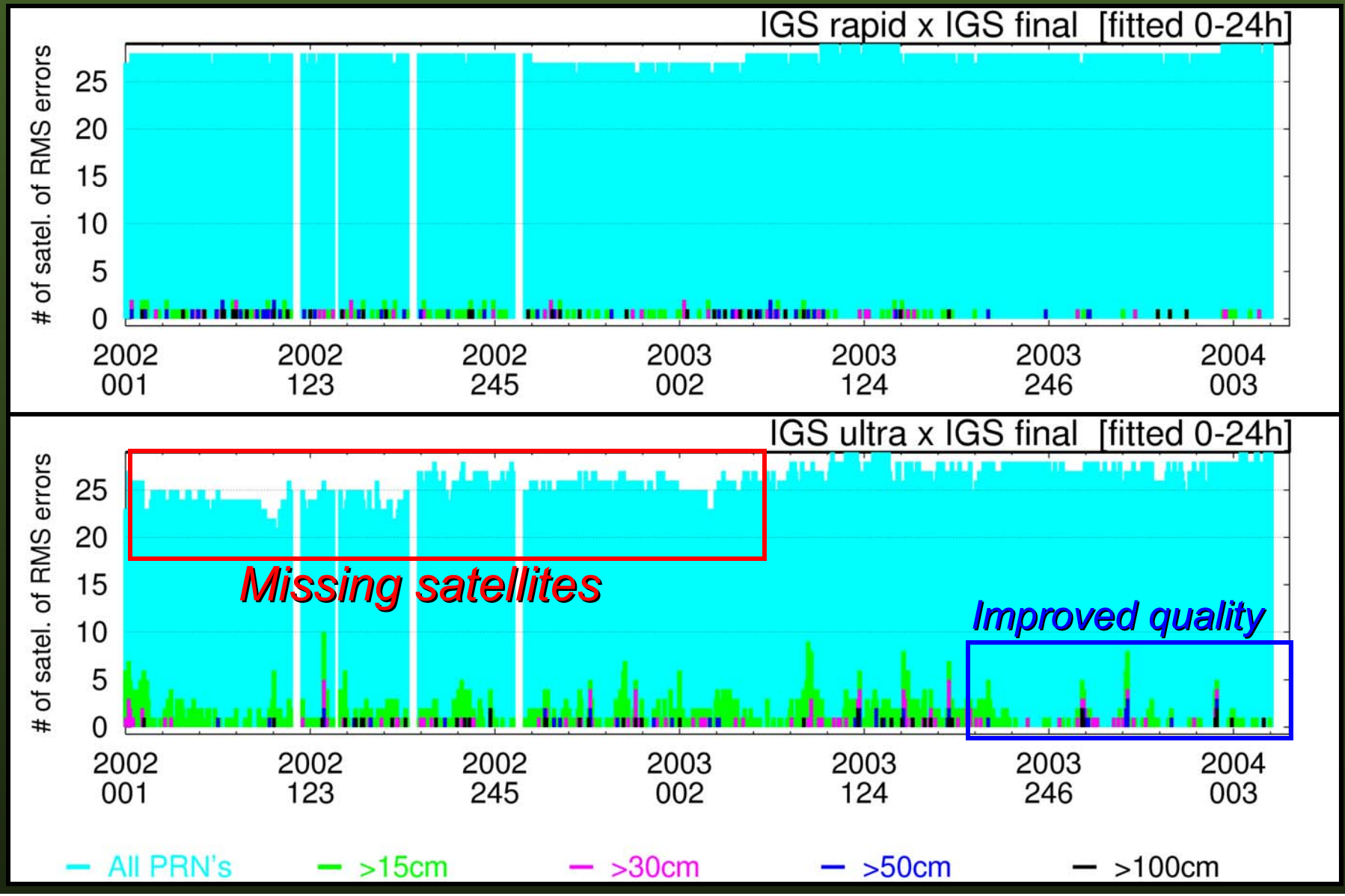
	Final	Rapid	Ultra-rapid	(Predicted)	Real-time
application	best post-proc	rapid post-proc	rapid post-proc RT	RT	RT
product	fitted	fitted	fitted + pred	predicted	fitted + pred?
data flow	daily	daily	(daily) hourly or RT	daily	real-time
latency upd.freq	14 days daily	17 hours daily	3 hours subdaily	17 hours daily	x sec/min sec/min
inevitable prediction			+ 15 hours	+ 48 hours	+ x hours ?
network	large	large	limited (large)	large	limited
operation run	interaction possible	interaction possible	full-automatic run	interaction possible	full-automatic run



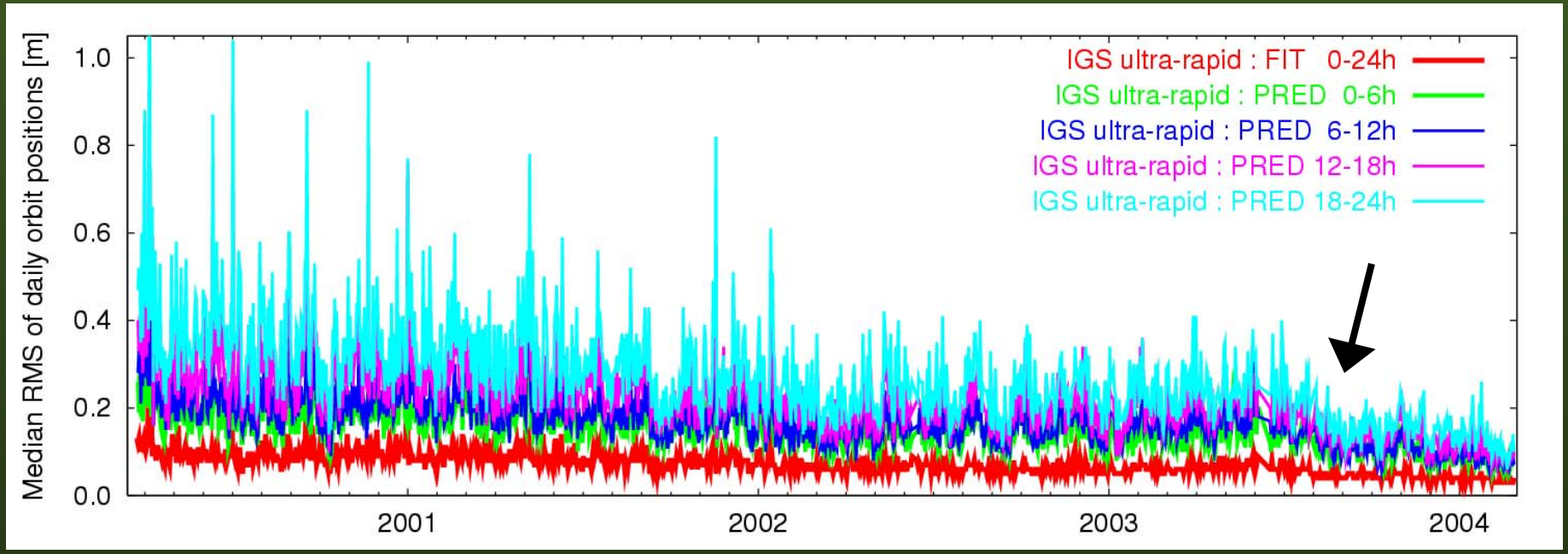
Ultra-rapid product 'extra' features

- product aimed for fitted & predicted portions
  - → can accommodate a wide-spectrum of applications
- possible various strategies applied:
  - sliding window processing
  - x-hour batch processing with subdaily-NEQ stacking
  - rapid (daily-)NEQs + subdaily-NEQ stacking
  - previous precise orbits refined with nrt-DATA
  - real-time derived product ….
  - → important for the robustness of the product
- dependence on NRT/RT data flow
  - → important redundant, but independent access to data
- full-automatic run necessary
  - → request on sufficient redundancy and IM of the analysis

IGR and IGU accuracy and completeness



Improved quality of IGS ultra-rapids



Significant quality improvements is comming with the CODE ultra-rapid contribution

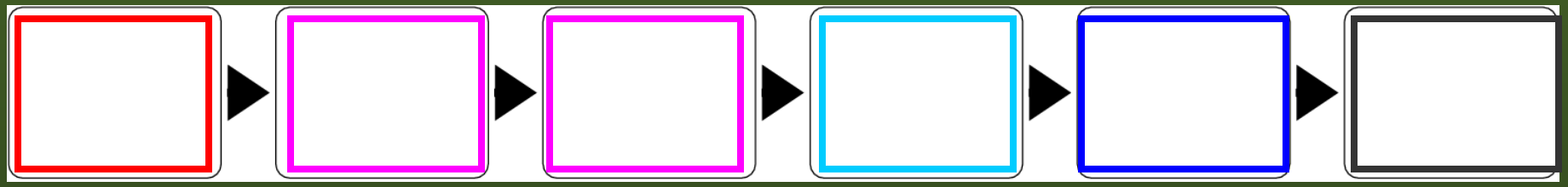
Ultra-rapids in Geodetic Observatory Pecný

- *January 2004 : GOP ultra-rapid solution contributes to IGS*
- *Bernese GPS software (V5.0beta), BPE & Perl scripts*
- *multi CPU i-686 architecture with Debian GNU/Linux*

Analysis characteristics:

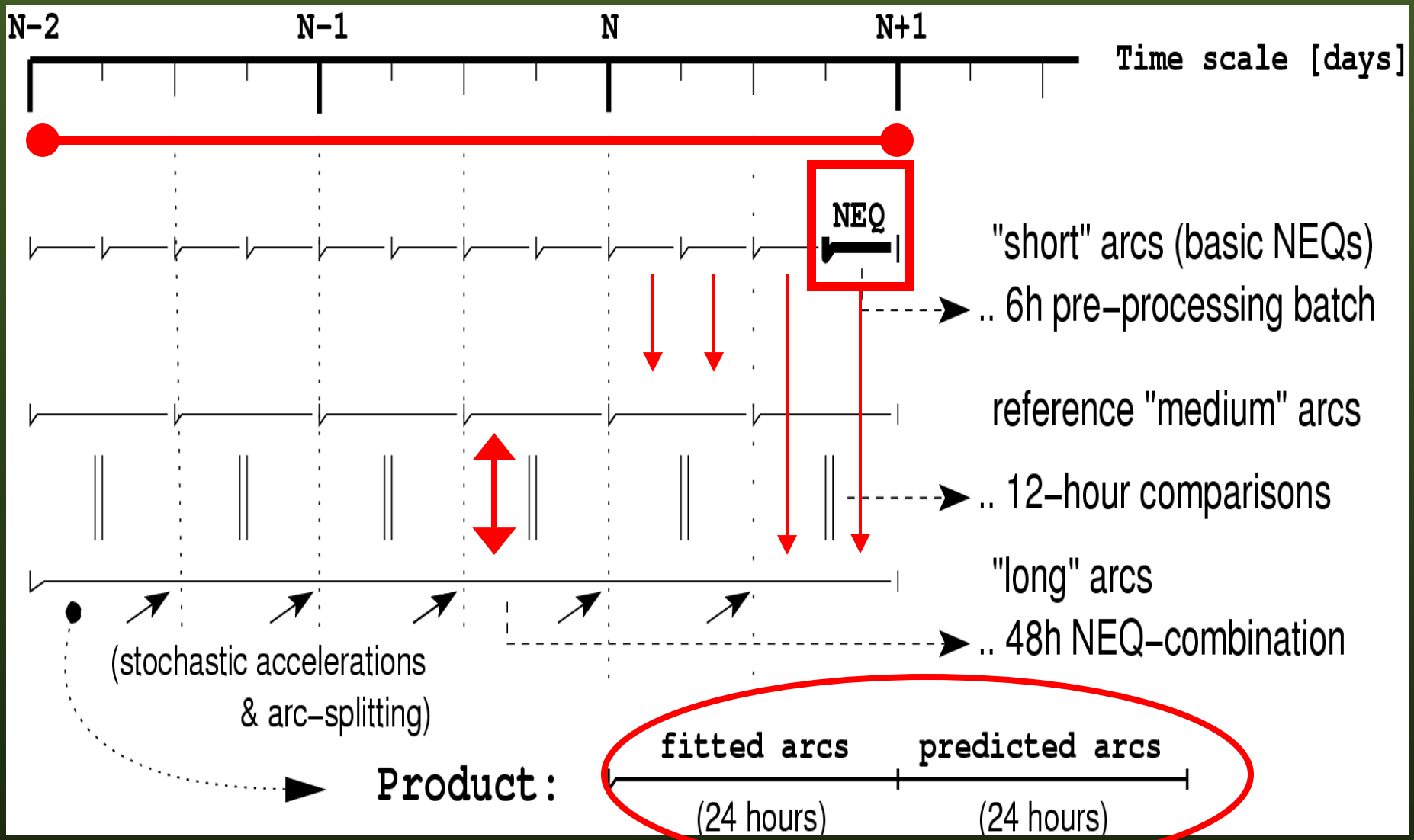
- *6–hour data pre-processing batches*
- *product updated every 3 hours*
- *orbits based on stacking the normal equations for last 3 days*
- *global network solution split into the clusters*
- *various iterative procedures for robust, fully-automatic run*
- *satellite clocks not estimated, but included from broadcasts*
- *10cm/20cm for fitted and 12h-predicted portions with respect to the IGS final orbits*

Nrt determination of the orbits in GOP

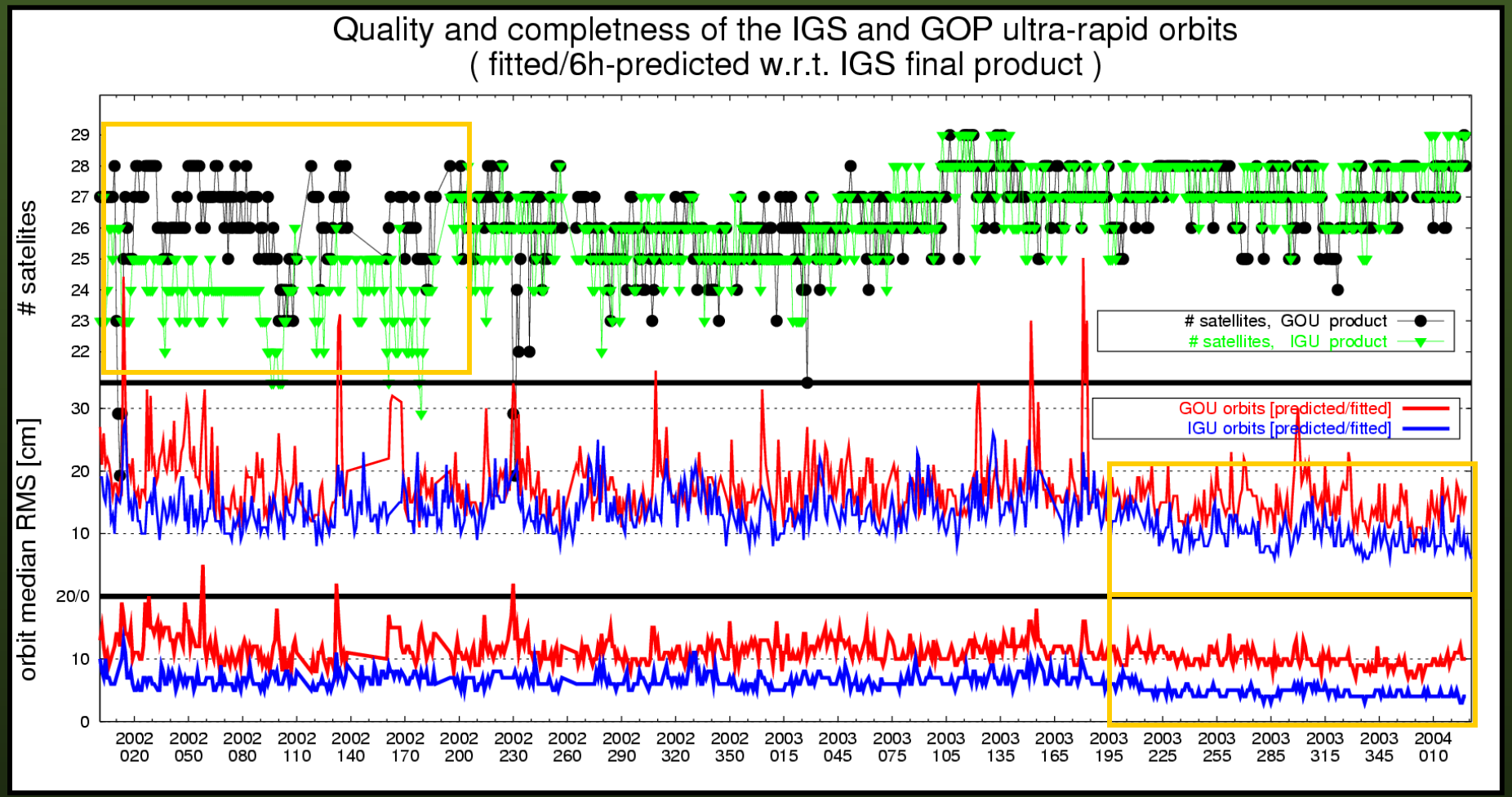


- hourly data from GOP NRT data center (global sites mirrored)
  concatenated broadcast messages for a priori orbits
  no manoeuvres information necessary
- 6-hour data batch pre-processing …. regional clusters → global clusters
  improved 1-day orbit arcs
- 3-day orbit combination based on 6-hours normal equations
  comparing long-arcs to short-arcs orbits for additional orbit parameteres
  orbit quality evaluation for accuracy code, possible excluding satetellites
- 6-hour batch pre-processing using final GOP orbits
  12-hour combined solution for global NRT troposphere parameters
- product archived in GOP DC, web-monitoring, database updating, …

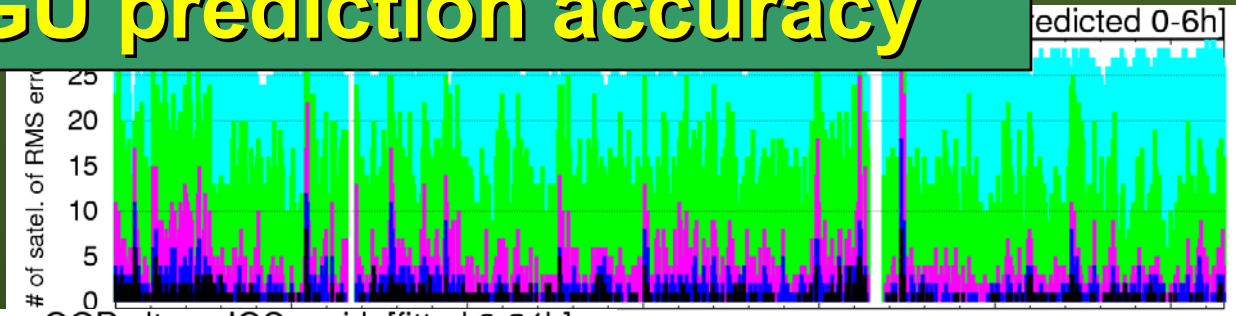
Final orbit combination (in GOP)

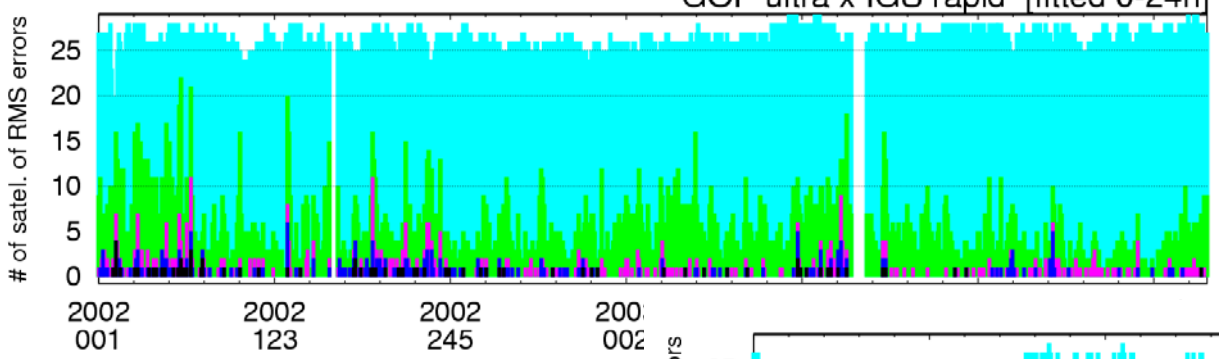


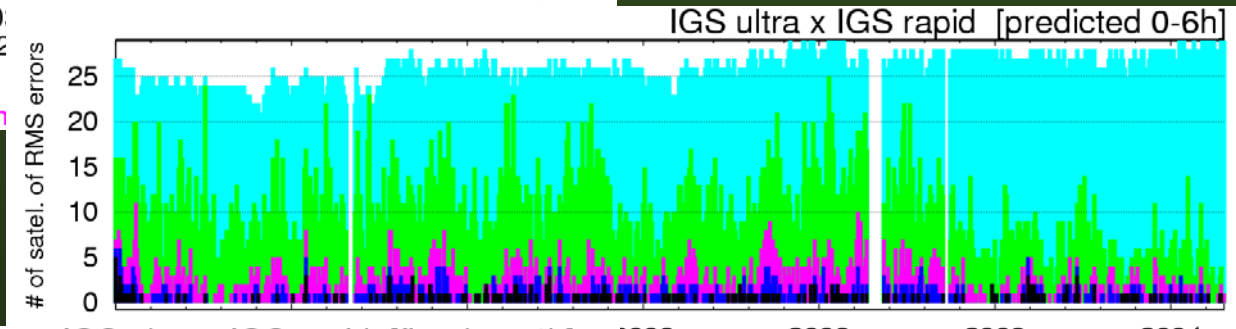
GOP & IGU orbits : 2002 - 2004 operation

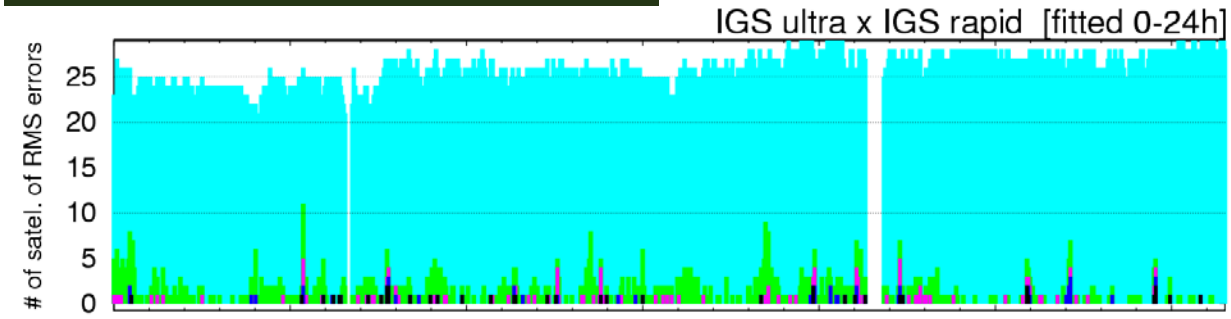


GOU & IGU prediction accuracy

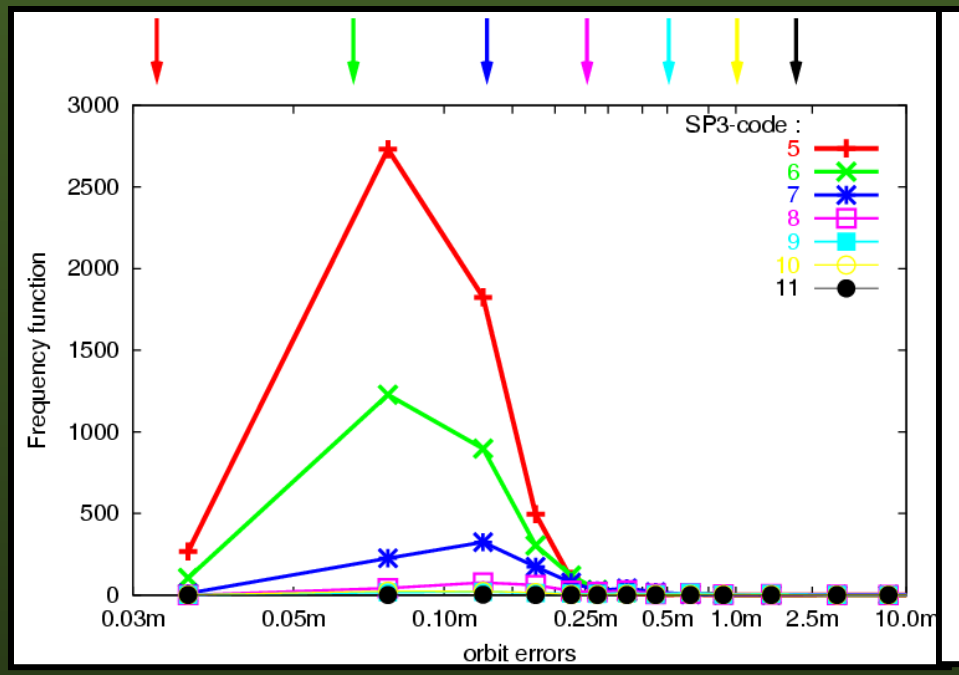


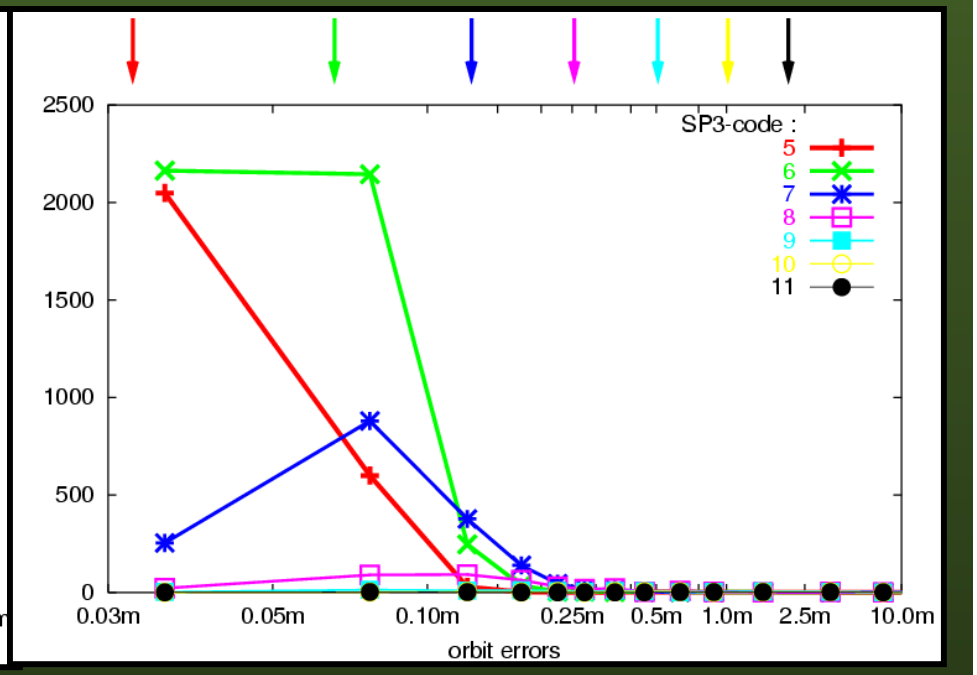


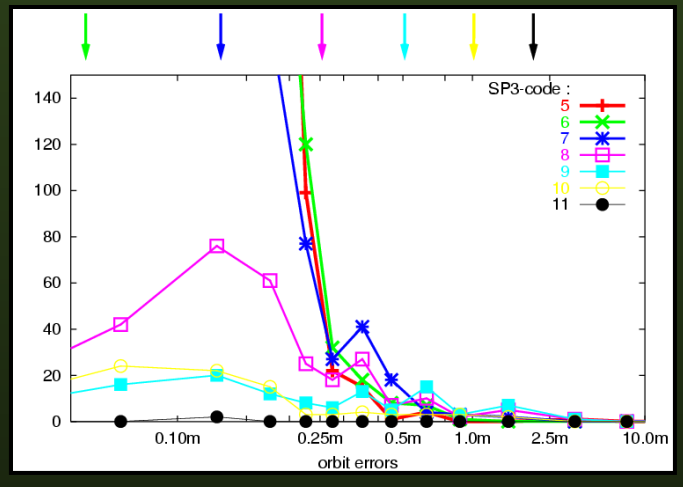


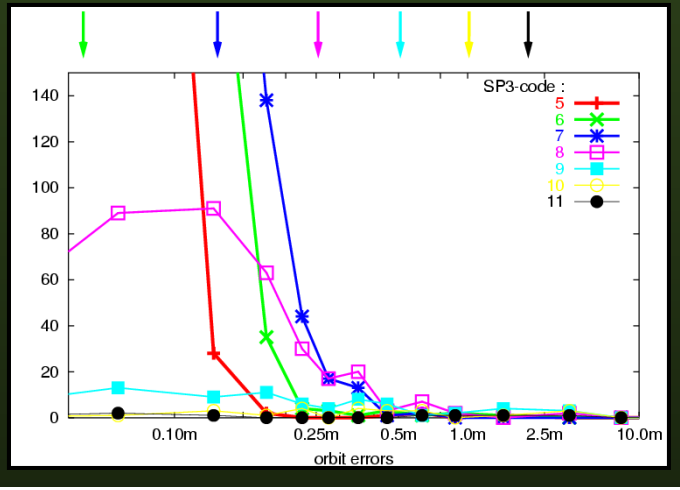


GOP, IGU orbits SP3-accuracy codes









Future of the ultra-rapid orbits

IGS ultra-rapid orbits are already very important product for a wide spectrum of the applications

a room for improvements :

- integration – further Global Navigition Satellite Systems
- completeness – GPS satellites
- accuracy & timeliness – faster update (3 - 6 hours)

to protect (/increase) robustness of the product by integration of:

(at least during the period of different RT/NRT/daily data access)

→ the use of various data flows (NRT, RT, DAILY)

→ strategies balanced for the timeliness & accuracy
for the orbit RT fitting × predicting

→ the use of various processing approaches !

GOP intentions within the IGS

To support the IGS ultra-rapid/NRT solutions

Motivations:

a) shared effort in accommodation of users' needs (orbits)

b) both-side profit from the robust IGS ultra-rapid orbits

c) support for the high-rate update cycle (≈ 4-8 / day)

d) feedback from the global IGS combination which helps us to improve our solution

Future developments for the GOP orbits:

- to improve accuracy code !
- incorporate integer ambiguity re-solution
- further reduction of missing satellites (manoeuvres, SfW tech. problem)
- improve data-flow (secondary access to the global stations)

Thank you.