



Processing of FORMOSAT-3/COSMIC Ionospheric Data at CDAAC

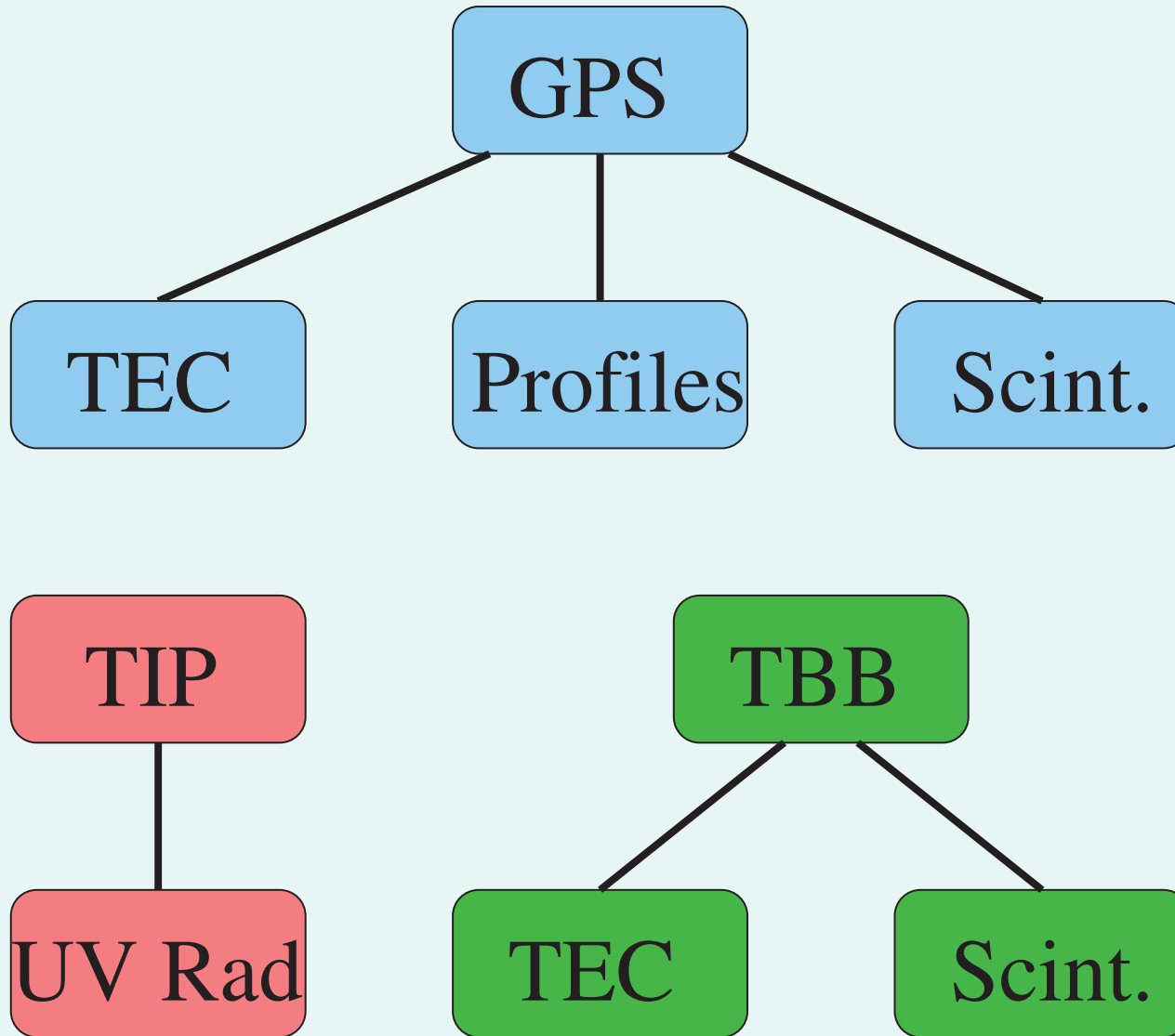
Stig Syndergaard

UCAR COSMIC Project Office

First FORMOSAT-3/COSMIC Data Users Workshop, Boulder, CO, Oct 16-18, 2006



COSMIC ionospheric data





Total electron content data (podTec)

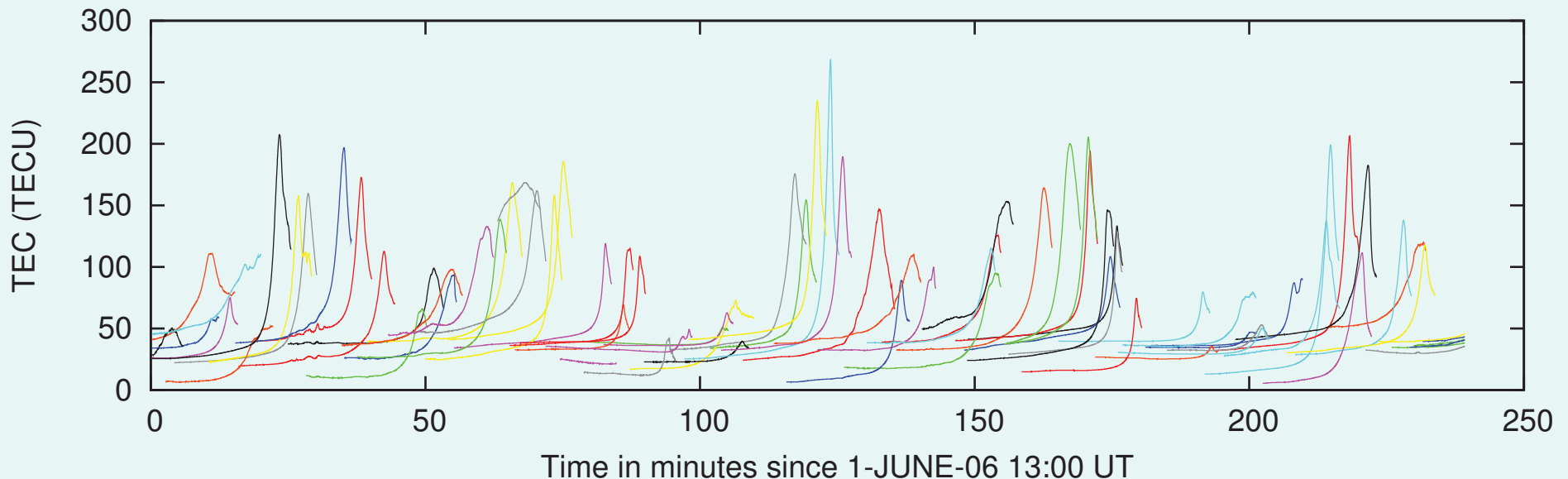


Number of TEC arcs
processed in the past week



2006.283:	2541
2006.284:	2612
2006.285:	3369
2006.286:	2528
2006.287:	2599
2006.288:	3226
2006.289:	2930
<hr/> Total:	<hr/> 19806

TEC arcs from one dump on June 1st, FM3 Aft-POD antenna (2006.152.003.02.01)





Absolute TEC processing



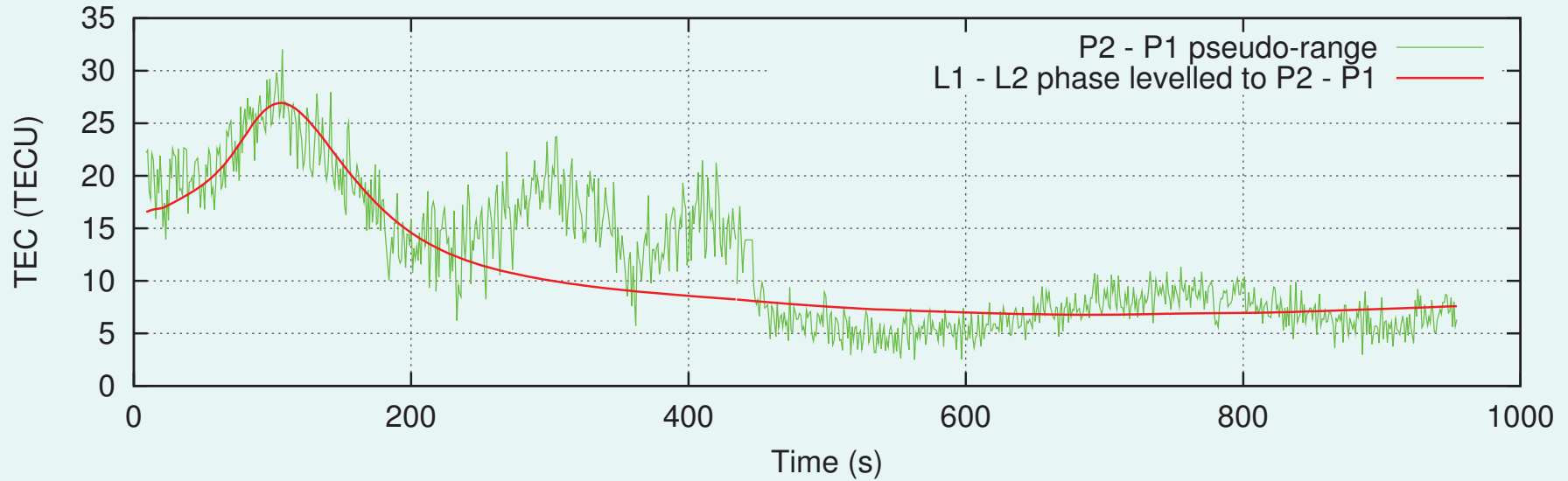
- Pseudo-range local multipath
- Phase cycle-slips & outliers (Blewitt, 1990)
- Phase-to-pseudorange leveling
- Differential code bias calibration



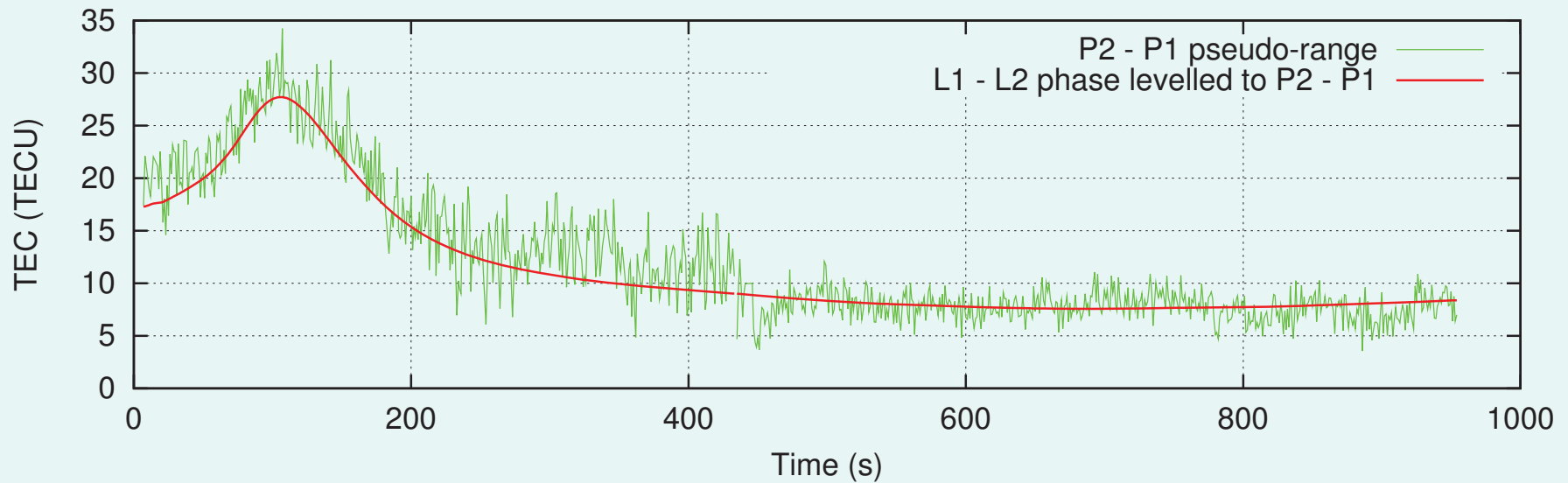
Pseudo-range local multipath calibration



C003.2006.284.04.46.0016.G11.00 --- without multipath calibration



C003.2006.284.04.46.0016.G11.00 --- with multipath calibration

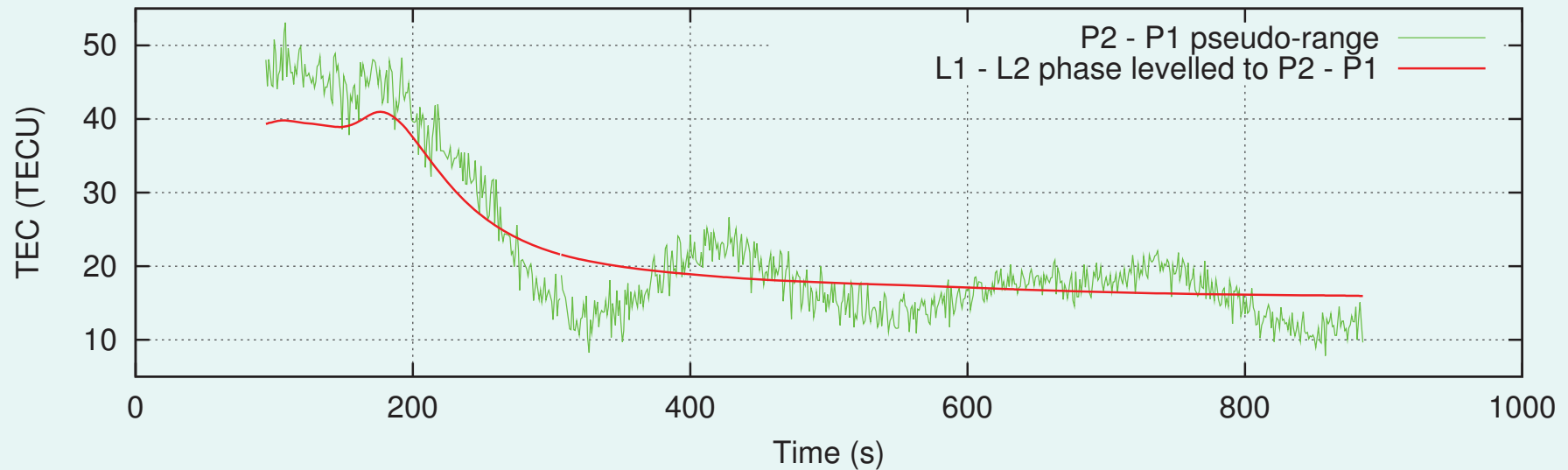




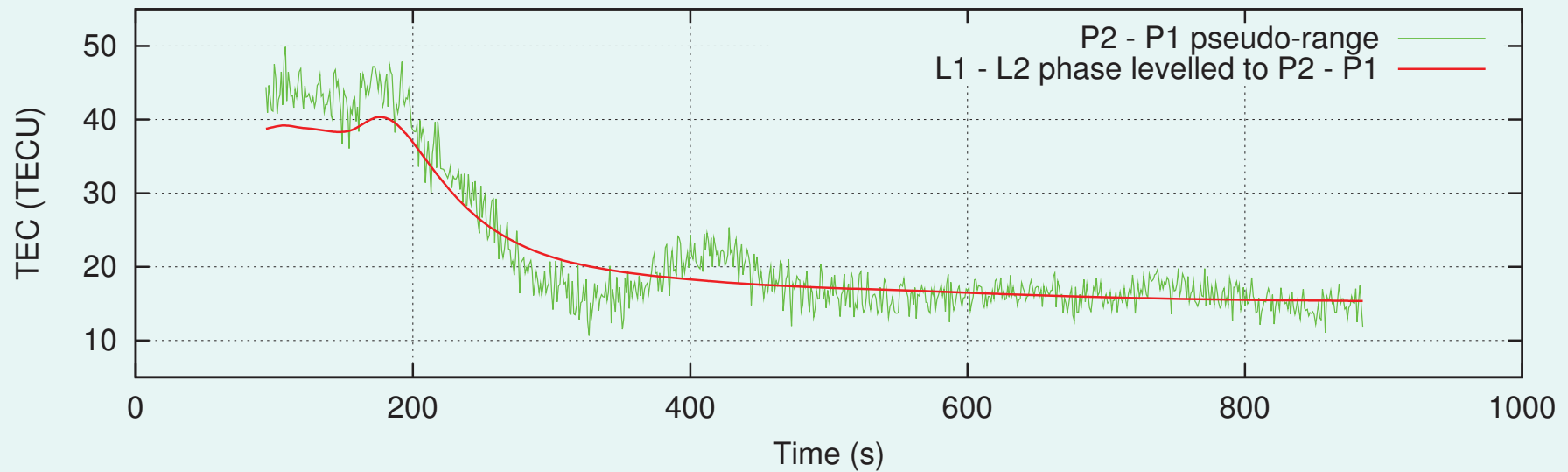
Pseudo-range local multipath calibration



C003.2006.283.23.48.0014.G16.00 --- without multipath calibration



C003.2006.283.23.48.0014.G16.00 --- with multipath calibration

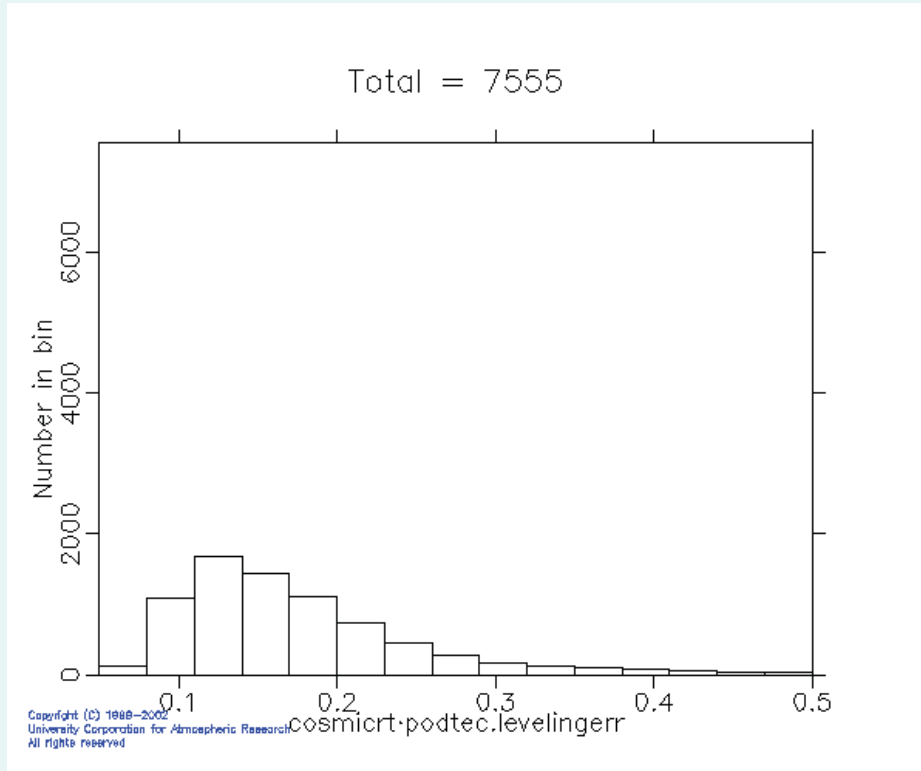




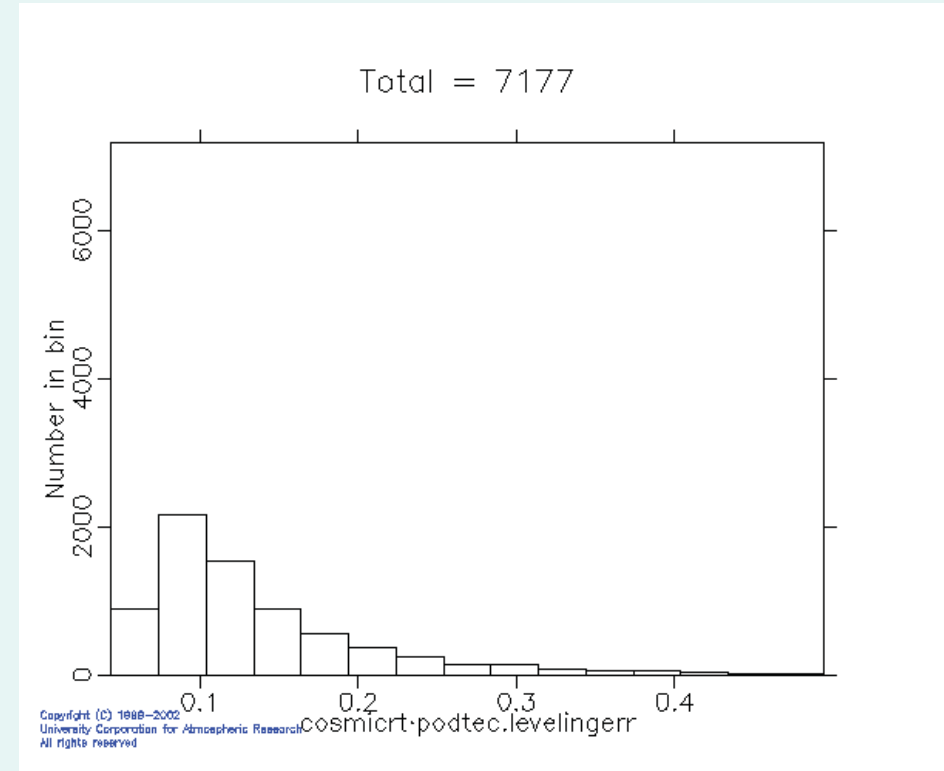
Phase-to-pseudorange leveling statistics



Without multipath calibration



With multipath calibration

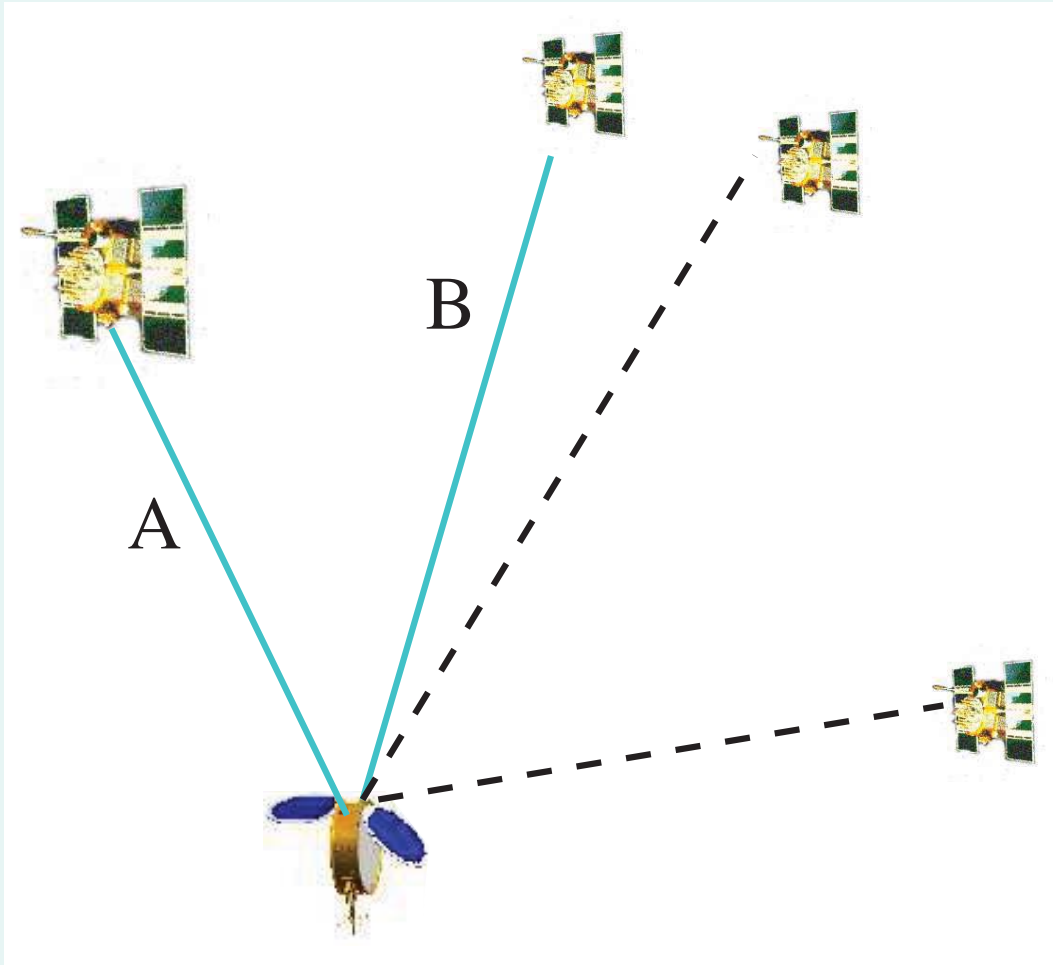


$$\text{levelingerr} = \frac{\text{RMS}}{\sqrt{N}} \text{ (TECU)},$$

N = number of data points in arc



LEO Differential Code Bias estimation



- Weighted average of paired observations

- Assumption:

$$\text{TEC}_A \mathcal{M}(\theta_A) = \text{TEC}_B \mathcal{M}(\theta_B)$$

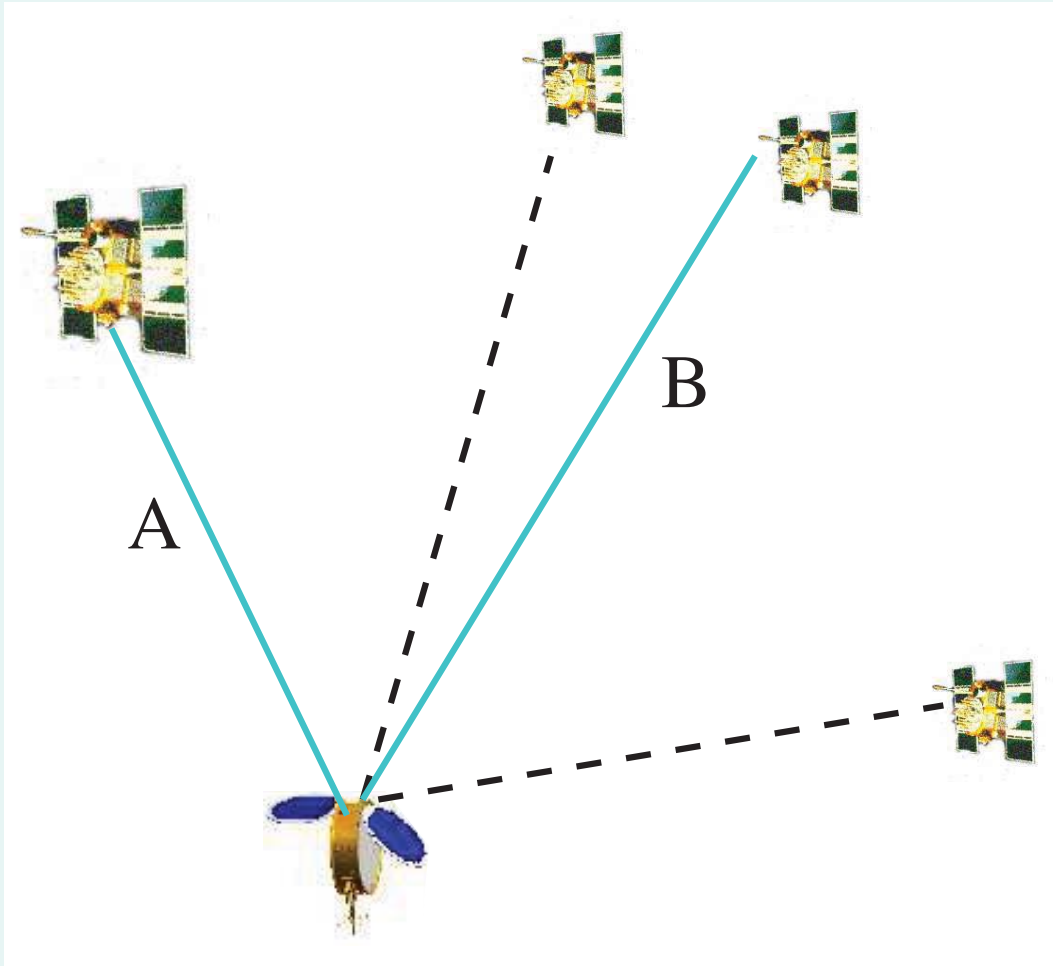
- Foelsche-Kirchengast (2002) geometric mapping function:

$$\mathcal{M}(\theta) = \frac{\sin \theta + \sqrt{\tilde{r}^{-2} - \cos^2 \theta}}{1 + \tilde{r}^{-1}}$$

$$\text{DCB}_{\text{leo}} = \frac{\sum (\mathcal{M}(\theta_B) - \mathcal{M}(\theta_A)) (\widehat{\text{TEC}}_A \mathcal{M}(\theta_A) - \widehat{\text{TEC}}_B \mathcal{M}(\theta_B))}{\sum (\mathcal{M}(\theta_B) - \mathcal{M}(\theta_A))^2}$$



LEO Differential Code Bias estimation



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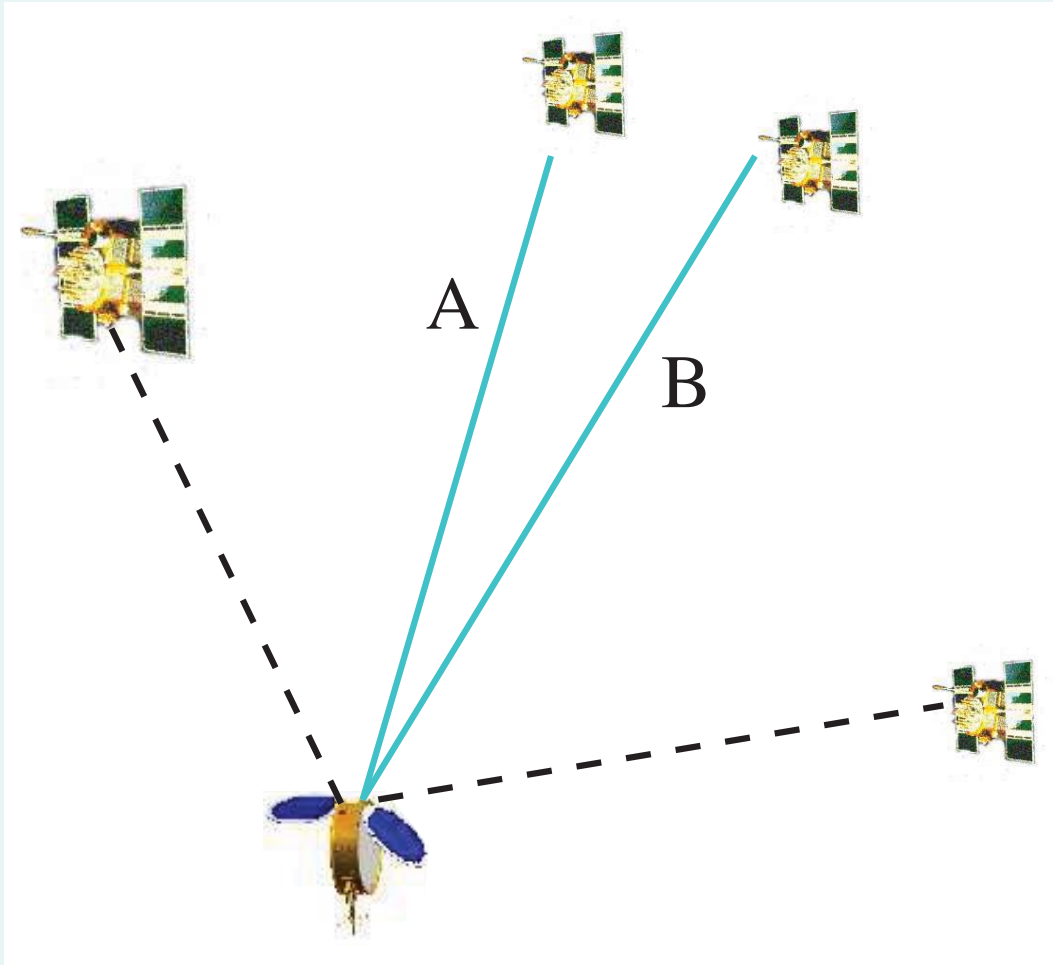
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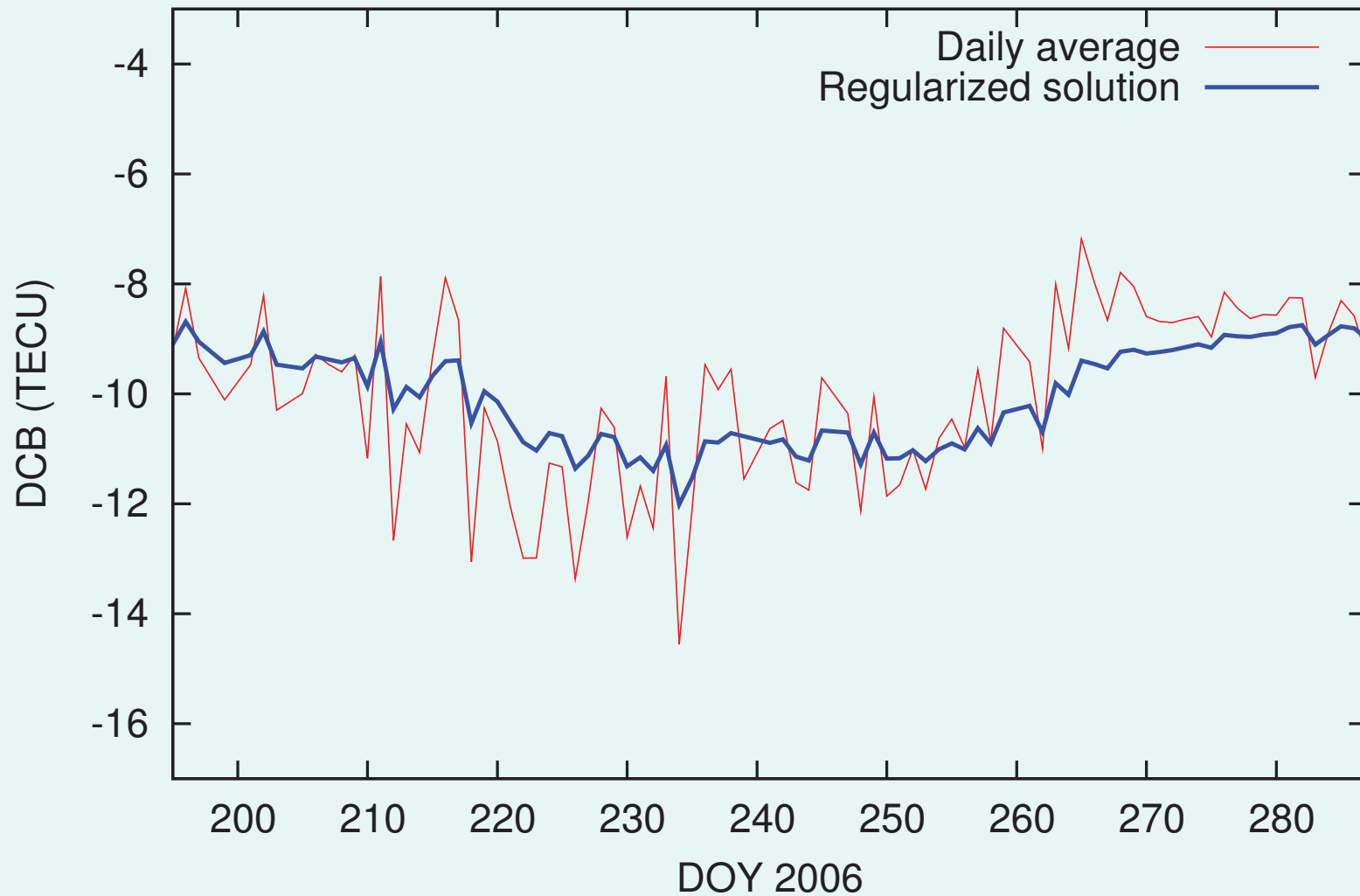
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LEO Differential Code Bias estimation



Near real-time DCB solution for FM5, POD 01

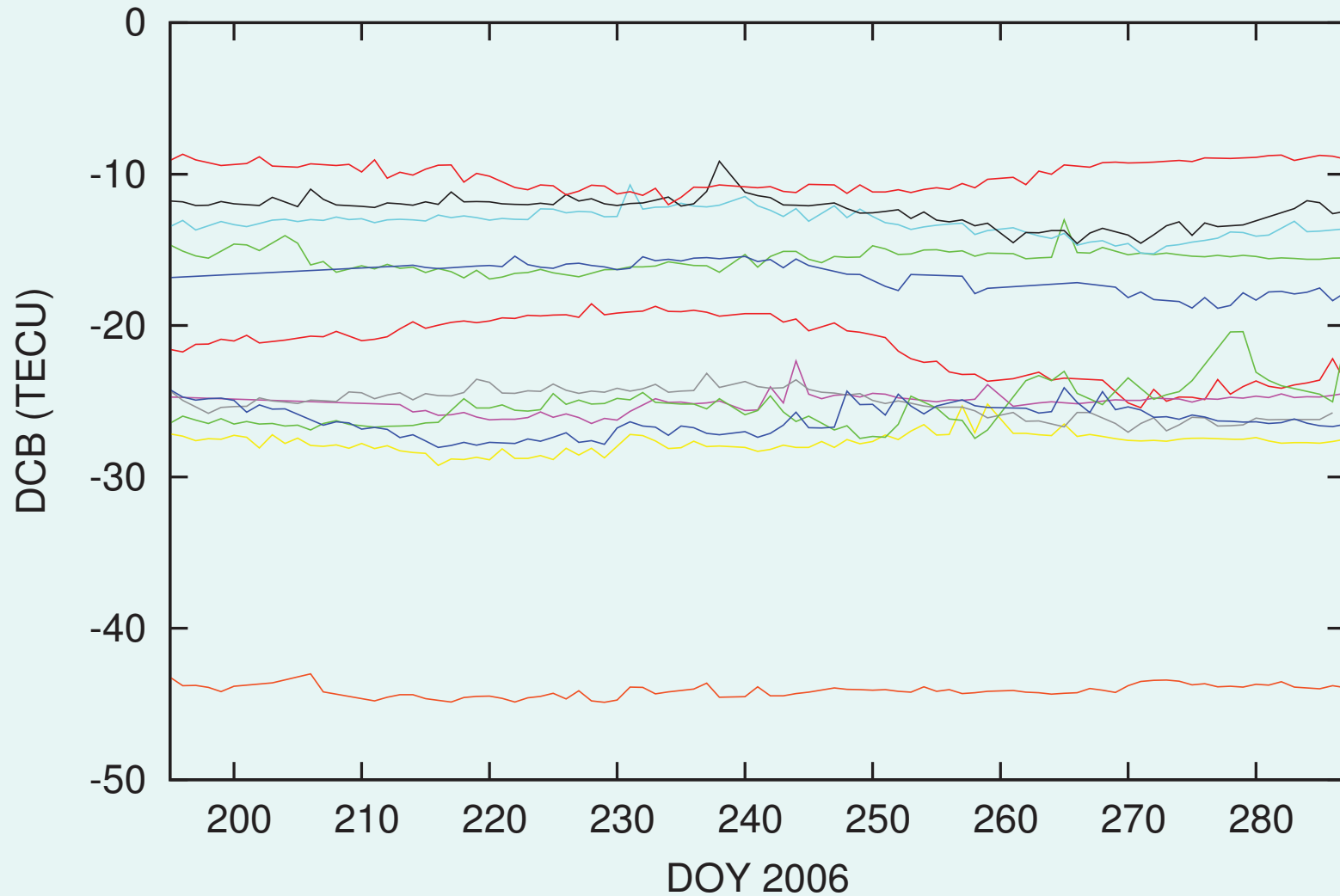




LEO Differential Code Biases (leoDcb)



Near real-time DCB solution for all 12 POD antennas

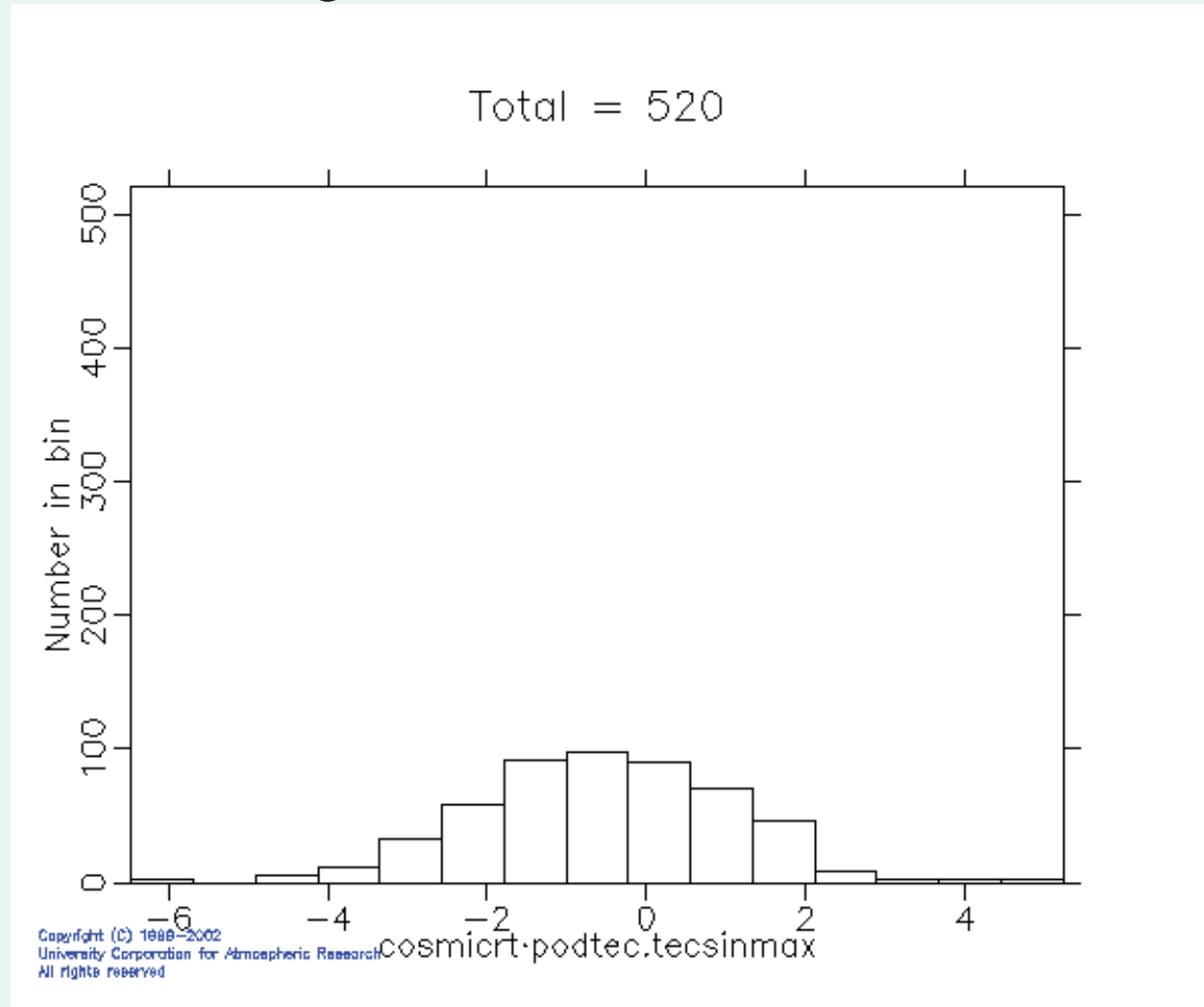




Absolute TEC statistics



TEC at elevation angles $> 45^\circ$, latitude $> 60^\circ$, local time < 7 am



$\text{tecsinmax} = \text{TEC} \sin \theta$ at maximum elevation (TECU)



Electron density profiles (ionPrf)

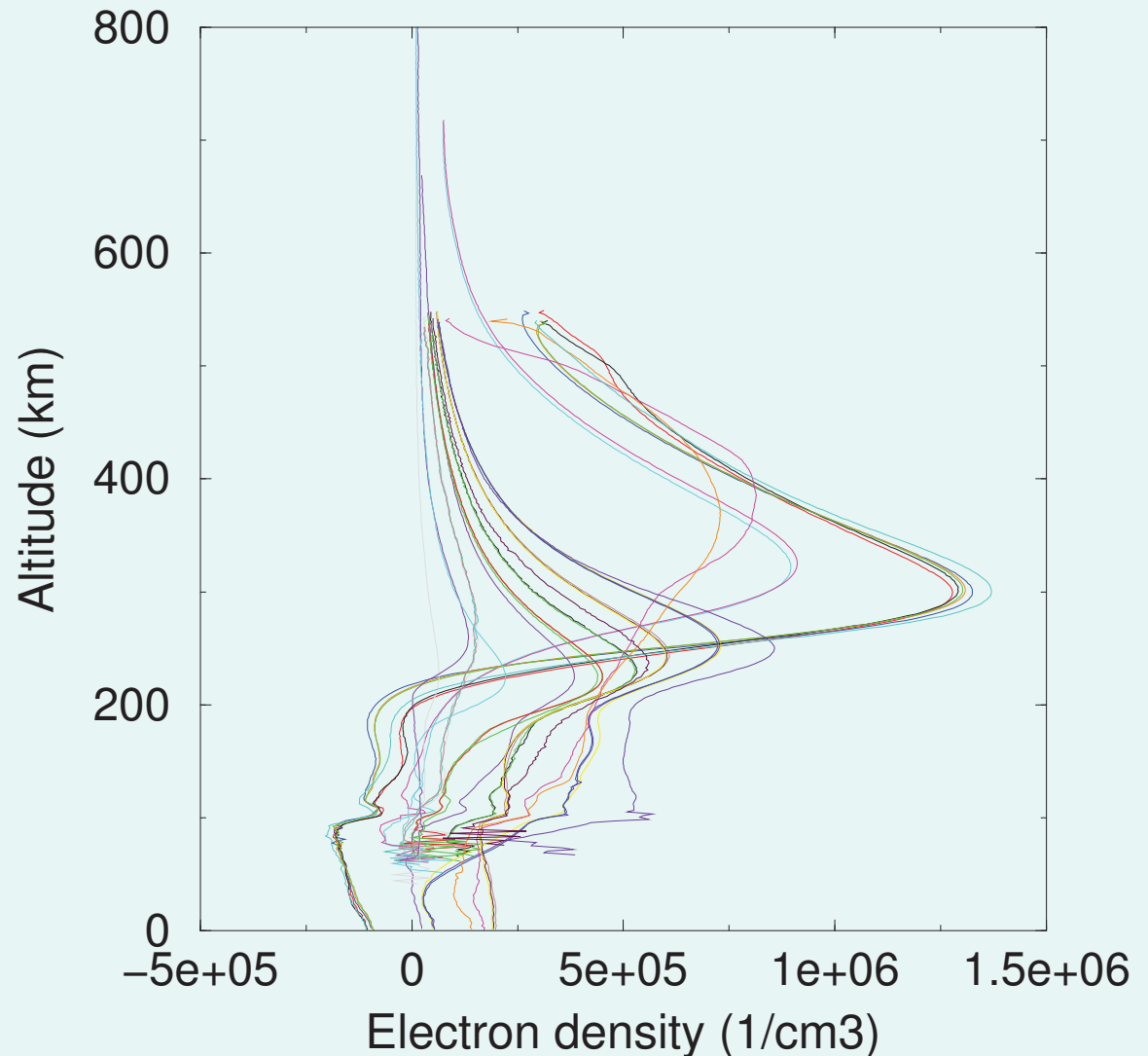


Number of
electron density
profiles processed
in the past week



2006.283:	1710
2006.284:	1790
2006.285:	2222
2006.286:	1714
2006.287:	1885
2006.288:	2184
2006.289:	1844
<hr/> Total:	<hr/> 13349

Profiles collected within 10 minutes on Oct 12





Electron density profile processing



- Subtracting positive elevation angle data from negative elevation angle (Schreiner et al., 1999)
- Model independent estimate of upper boundary electron density (Syndergaard et al., 2006)
- Profile retrieval based on straight-line and spherical symmetry assumptions



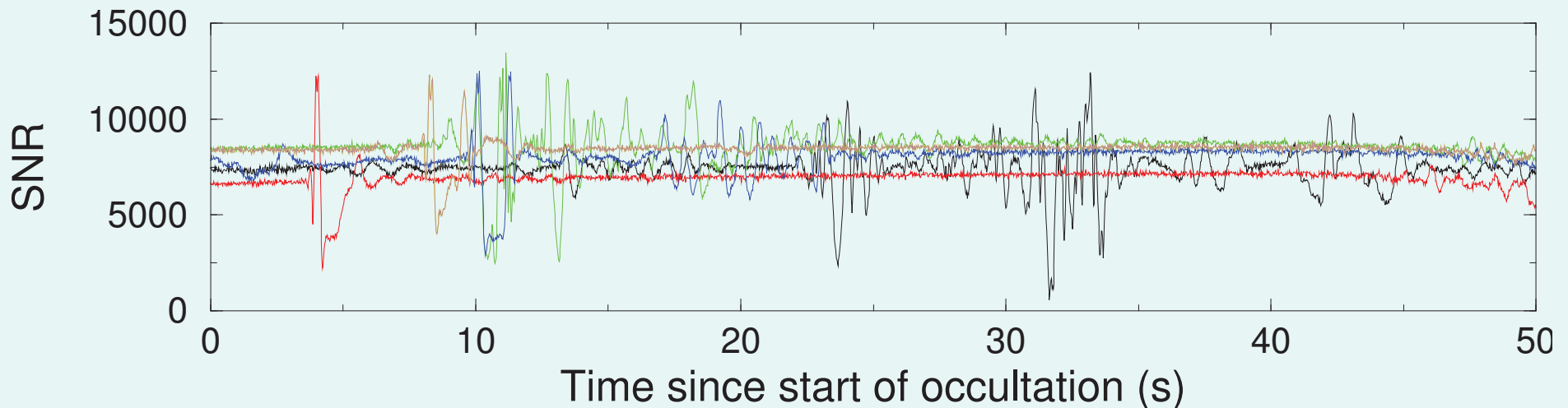
High-rate scintillation data (atmPhs)



Number of high-rate excess phase and amplitude profiles processed in the past week \Rightarrow

2006.283:	1530
2006.284:	1635
2006.285:	2114
2006.286:	1664
2006.287:	1807
2006.288:	2061
2006.289:	1830
<hr/> Total:	<hr/> 12641

Examples of large amplitude scintillations on Sep 22





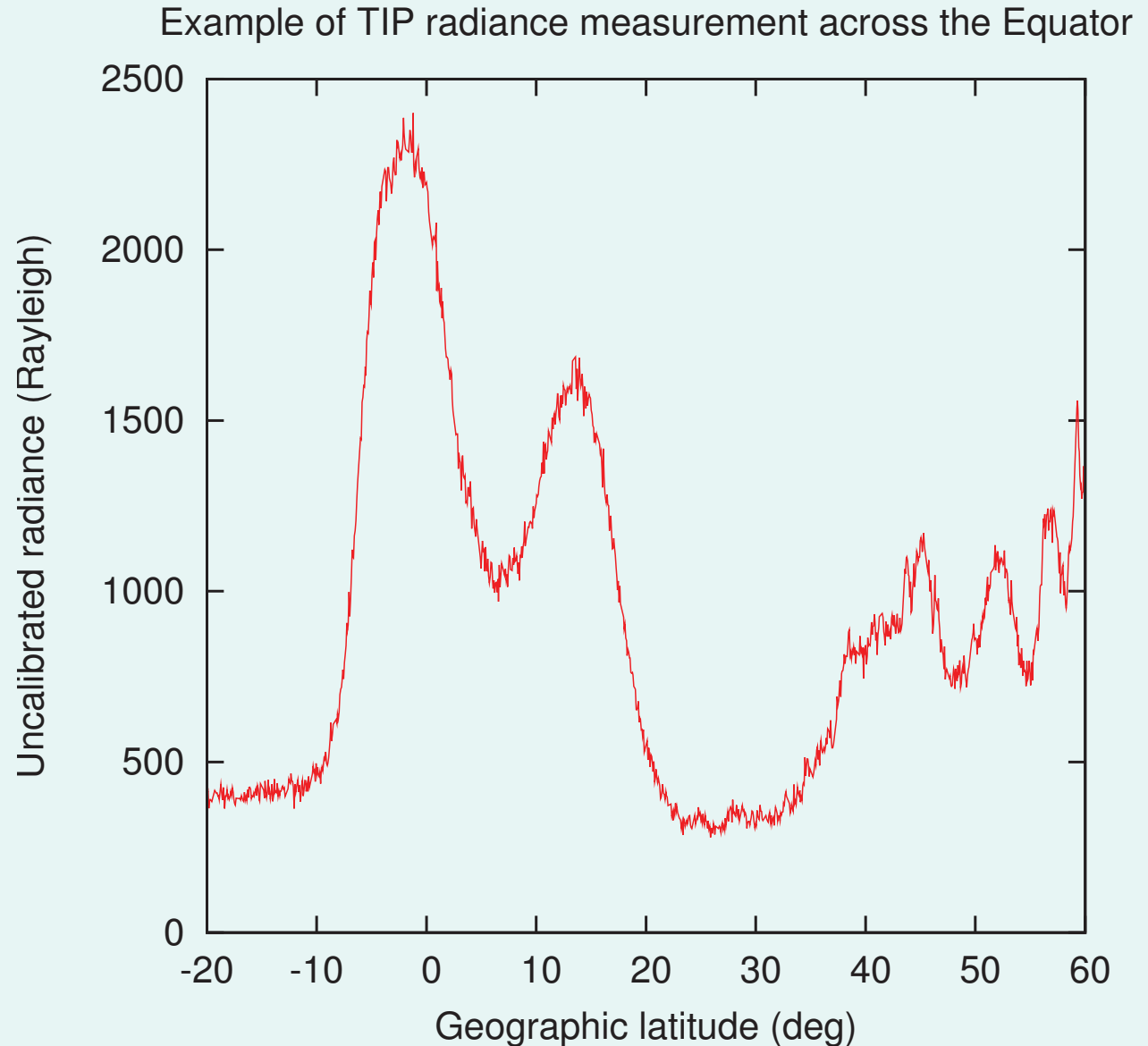
TIP counts and radiances (tipLv1)



Number of
TIP dumps
processed in
the past week



2006.283:	5
2006.284:	8
2006.285:	16
2006.286:	12
2006.287:	10
2006.288:	18
2006.289:	20
<hr/> Total:	89





Tri-Band Beacon data (tbb???)





Caveats and anticipated improvements

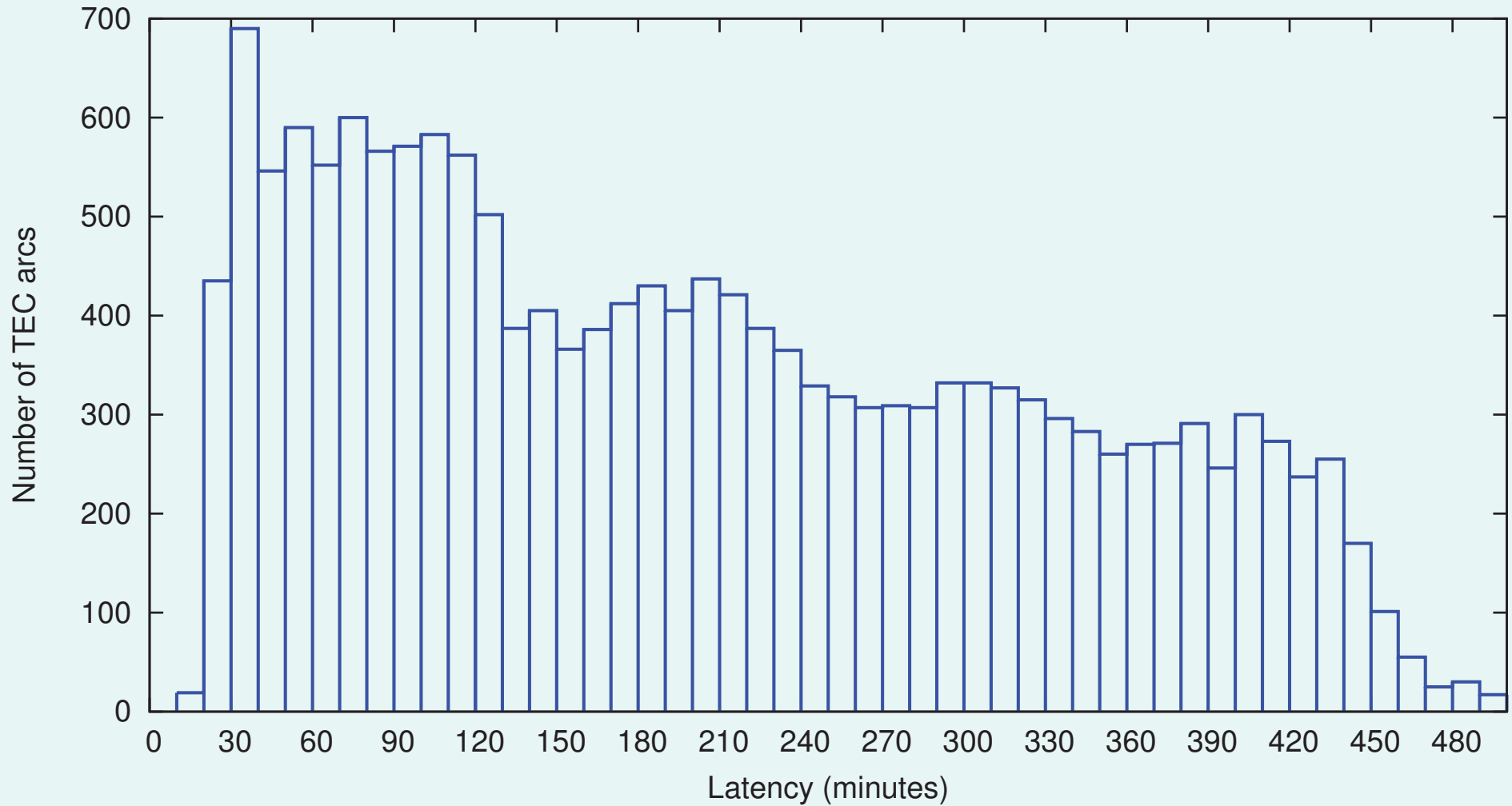


- Absolute TEC and DCBs seem biased by a few TECU (should be addressed soon – look out for new version numbers 0001.0002 on real-time podTec and leoDcb files)
- Many ionospheric rising occultations start too late (working with JPL to lower the starting altitude for rising occultations)
- TIP data processing mostly working thanks to hard work from Scott Budzien (NRL) – radiances not yet calibrated
- tipLv1 data files soon to be available from the CDAAC website
- Latency...



Absolute TEC latency

Latency of podTec data for the past week

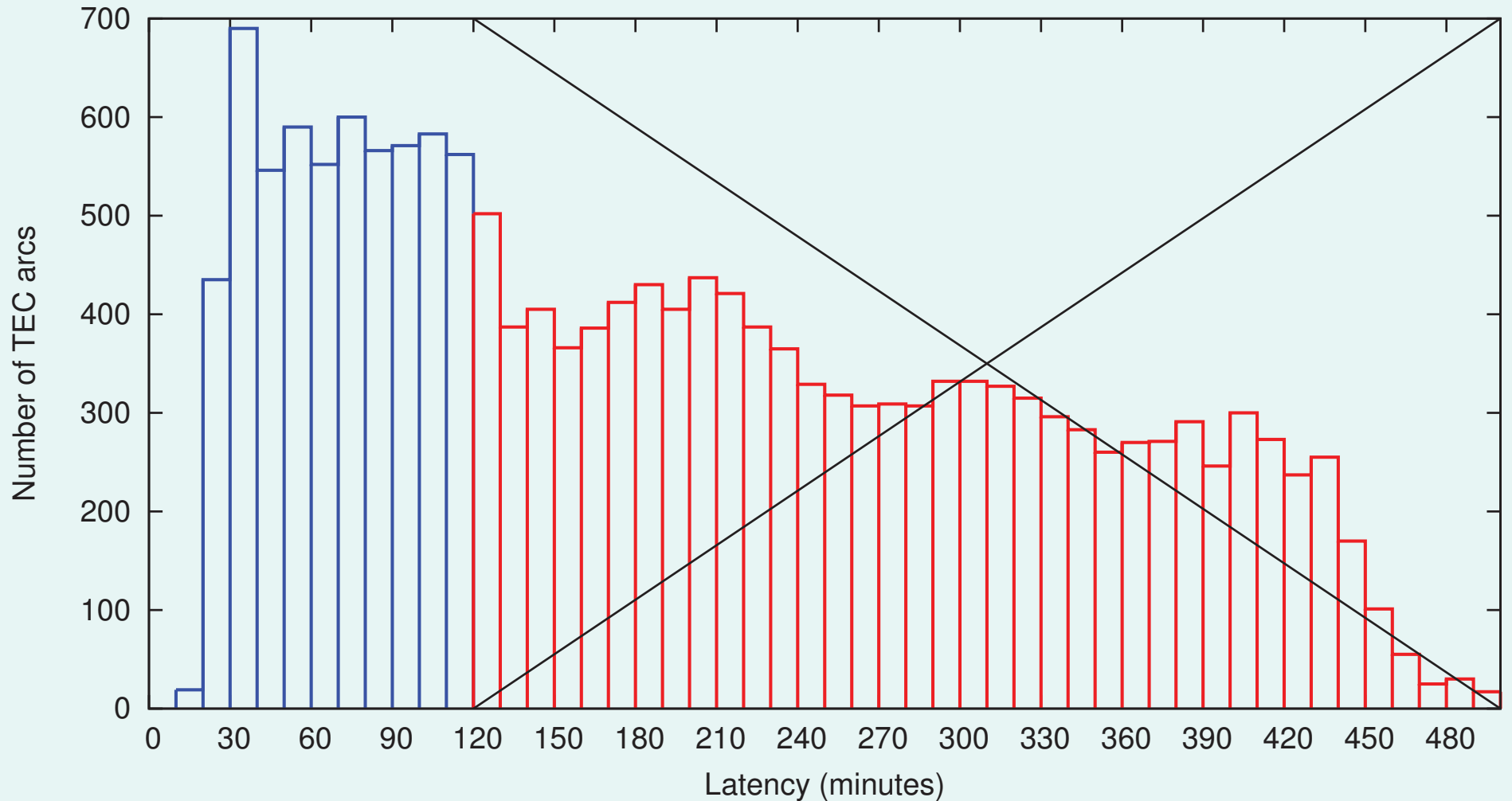


— this is where we are...



Absolute TEC latency

Latency of podTec data for the past week



— this is our goal!