Reassessment of the Legacy Geodetic Satellite WESTPAC for ILRS Tracking

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WESTPAC

WESTPAC is a geodetic satellite that was launched on 10th July 1998 into a sun synchronous orbit at 835 km altitude, 98° inclination and 0.0 eccentricity.

It was a joint project of Electro Optic Systems (EOS, Australia) and the Russian Space Agency (RSA).

It has a diameter of 245 mm, with 60 corner cubes and a mass of 23.757 kg.

WESTPAC

Each retro-reflector has a baffle tube 31.5mm high that narrows the acceptance angle to 26° full angle.

As a result, only a single cube at a time can be observed by SLR.

This results in a zero-signature SLR target.

The centre-of-mass offset can be modelled with an accuracy of 0.5mm.

[Rutkowska, M., Noomen, R., 2002. Orbit analysis of the satellite WESTPAC. Adv. Space Res. 30 (2), 265–270. http://dx.doi.org/10.1016/S0273-1177(02)00294-6]

WESTPAC

WESTPAC was launched with a spin period of around of 3–6 s. The initial spin axis was aligned with the orbital velocity vector.

A retro-reflector is not always visible, which results in intermittent returns and can frustrate target acquisition.

ILRS support for WESTPAC ended in December 2002 because the data set was weak and was not used in the analysis community.

[Kucharski D, Lim H, Kirchner G, Koidl F (2014) Spin parameters of low earth orbiting satellites Larets and Stella determined from satellite laser ranging data. Adv Space Res 53(1):90–96]

WESTPAC -2024

Since ILRS tracking of WESTPAC ended, there have been two important changes:

- Satellite predictions are now provided much more regularly in the Consolidated Prediction Format (CPF). These are not restricted to a particular orbital model and require less corrections for time bias and range bias.

- A set of new generation, high performance kHz stations began operations.

WESTPAC –NORAD

WESTPAC originally used the NORAD number 25394.

It was later reassigned due to a clash with a Russian natural resources sensing satellite, RESURS-O 1N4.

It was given the new NORAD number of 25398.

But there was still some uncertainty over which target was WESTPAC. At least one other satellite released in the launch, TECHSAT 1B, carried retro-reflectors.
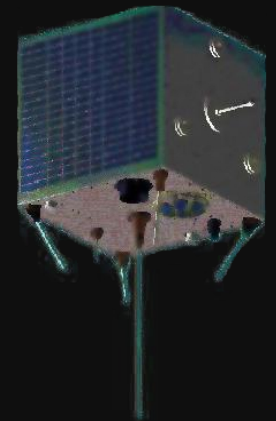
WESTPAC -NORAD

The Graz team took light curves of some of the launch objects. They found 25396 to be tumbling.

25394 and 25398 both showed constant light curves along their passes, no periodic phenomenon.

WESTPAC is visible at night when it's illuminated by the Sun.

NORAD# 25396 Light Curve by SLR Graz
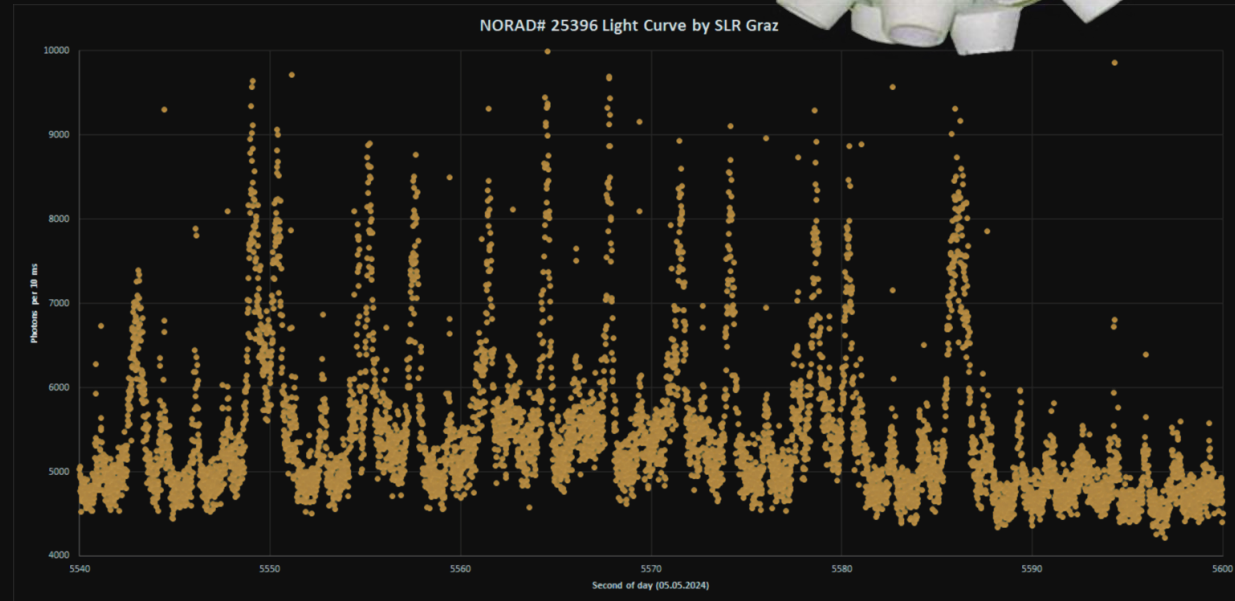
WESTPAC -NORAD

R. Sherwood at the SGF looked at the Space-Track TLE history.

WESTPAC -NORAD

25394

25395
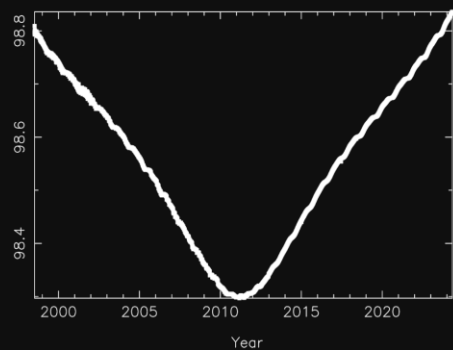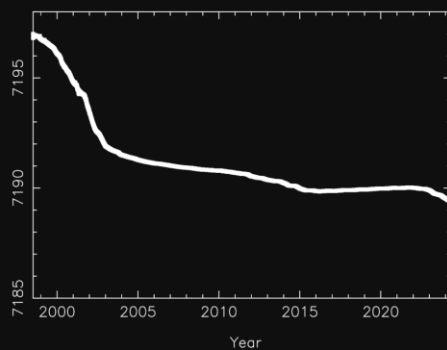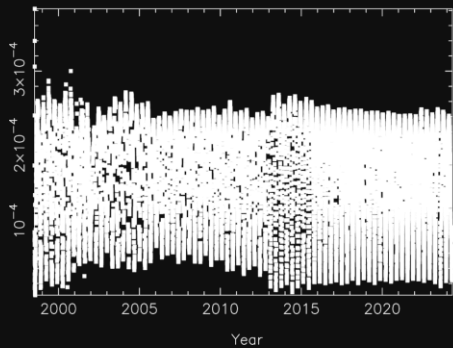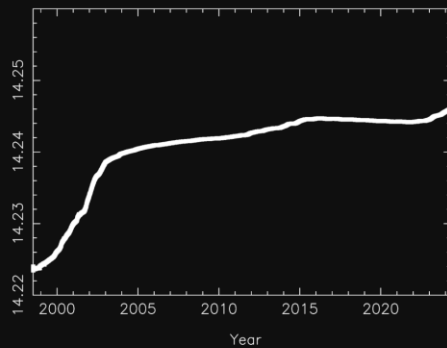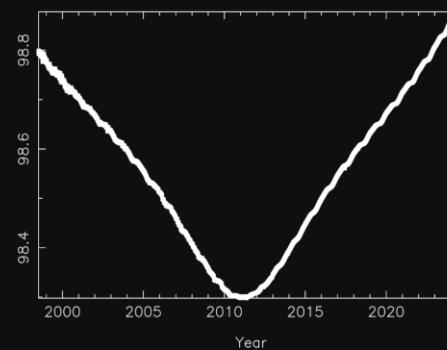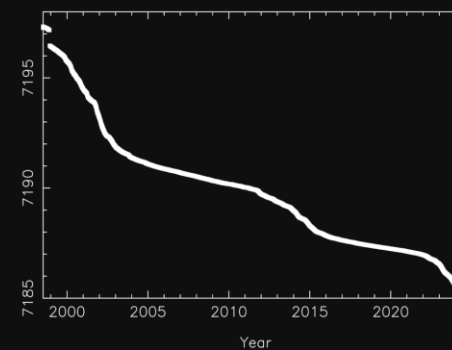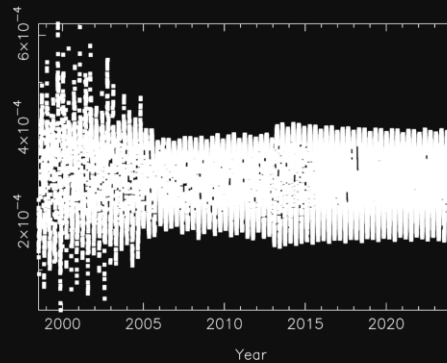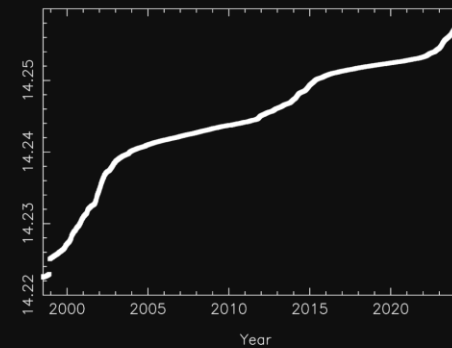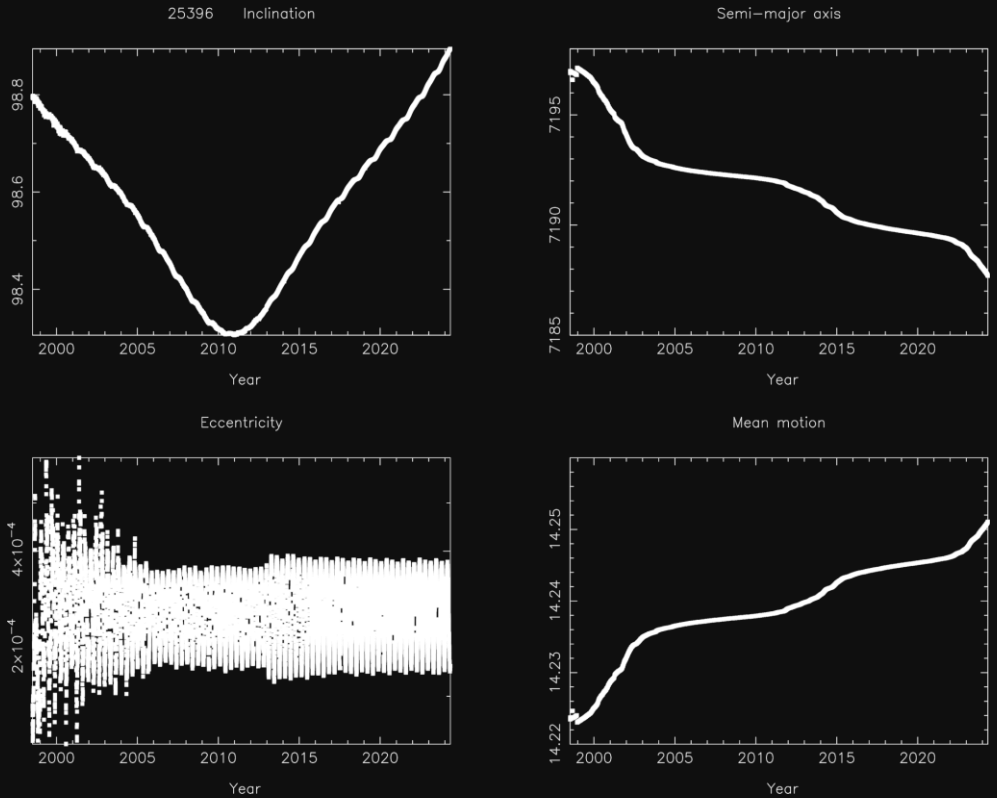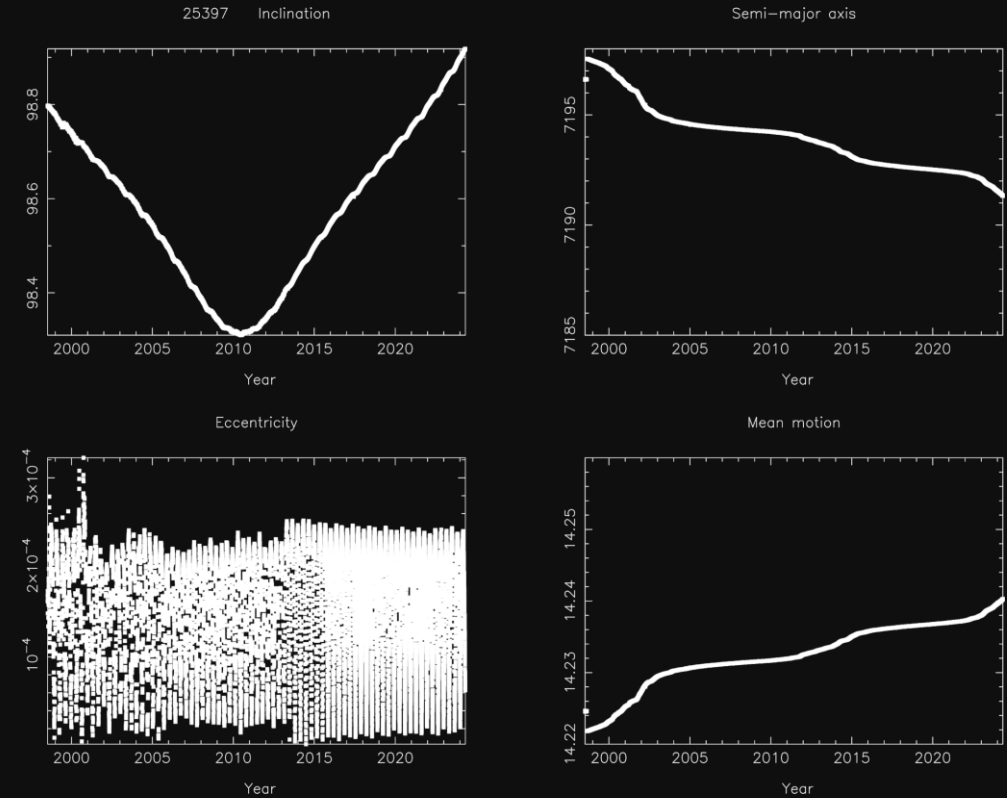
WESTPAC -NORAD

WESTPAC -NORAD

25398 - WESTPAC

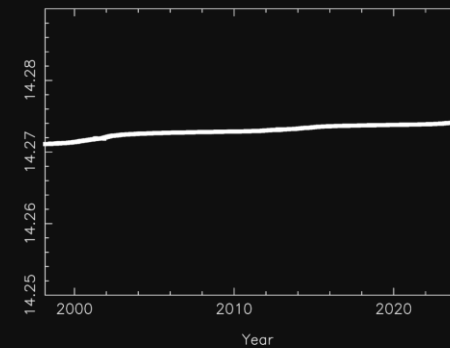## 22824 - Stella
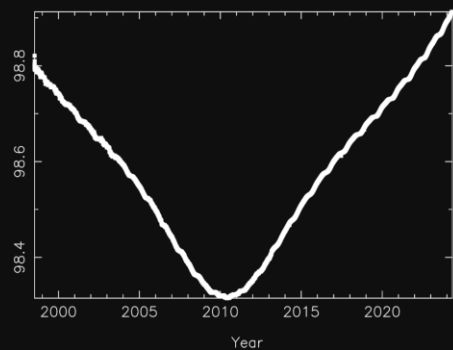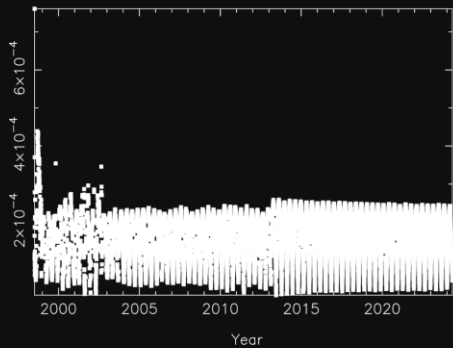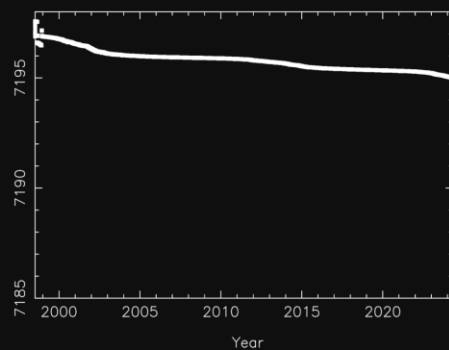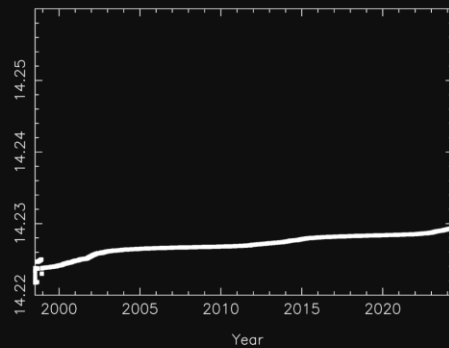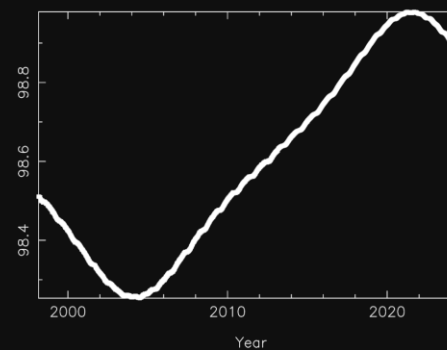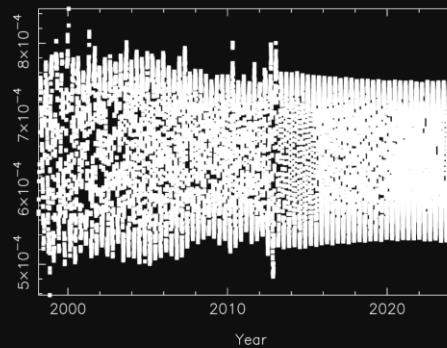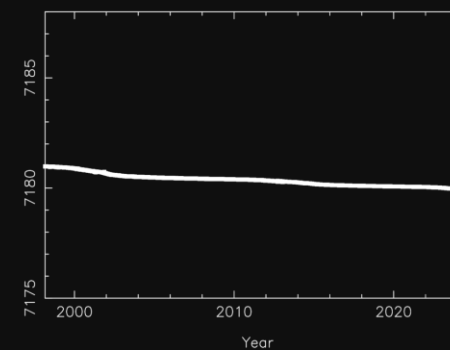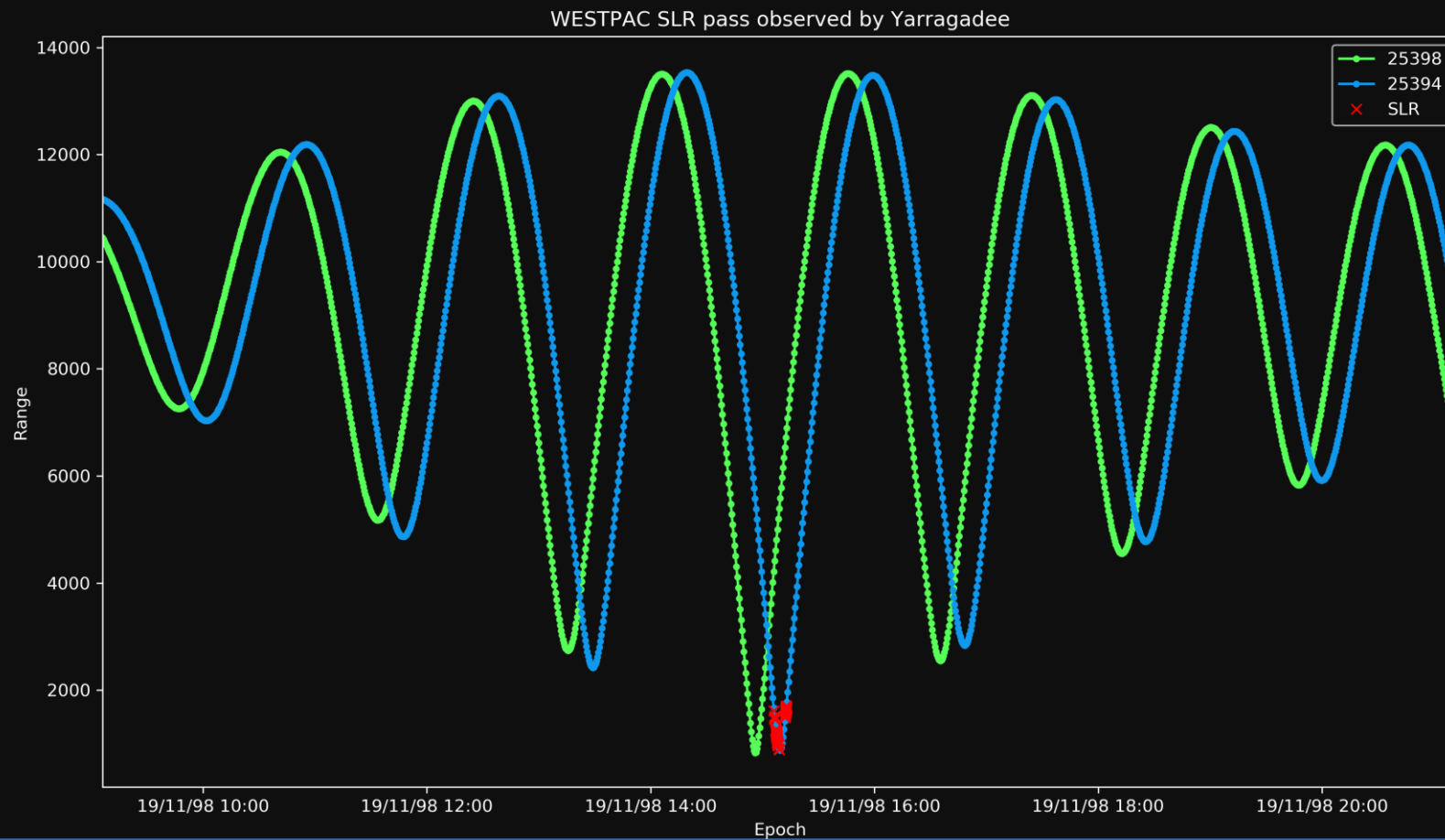
WESTPAC -NORAD

It was also possible to look at the archive SLR data observed in 1998 and 1999 by:

- Converting TLEs to CPFs

- Converting MERIT II full-rate data to CRD data, using the sample code by R. Ricklefs available on the ILRS website.
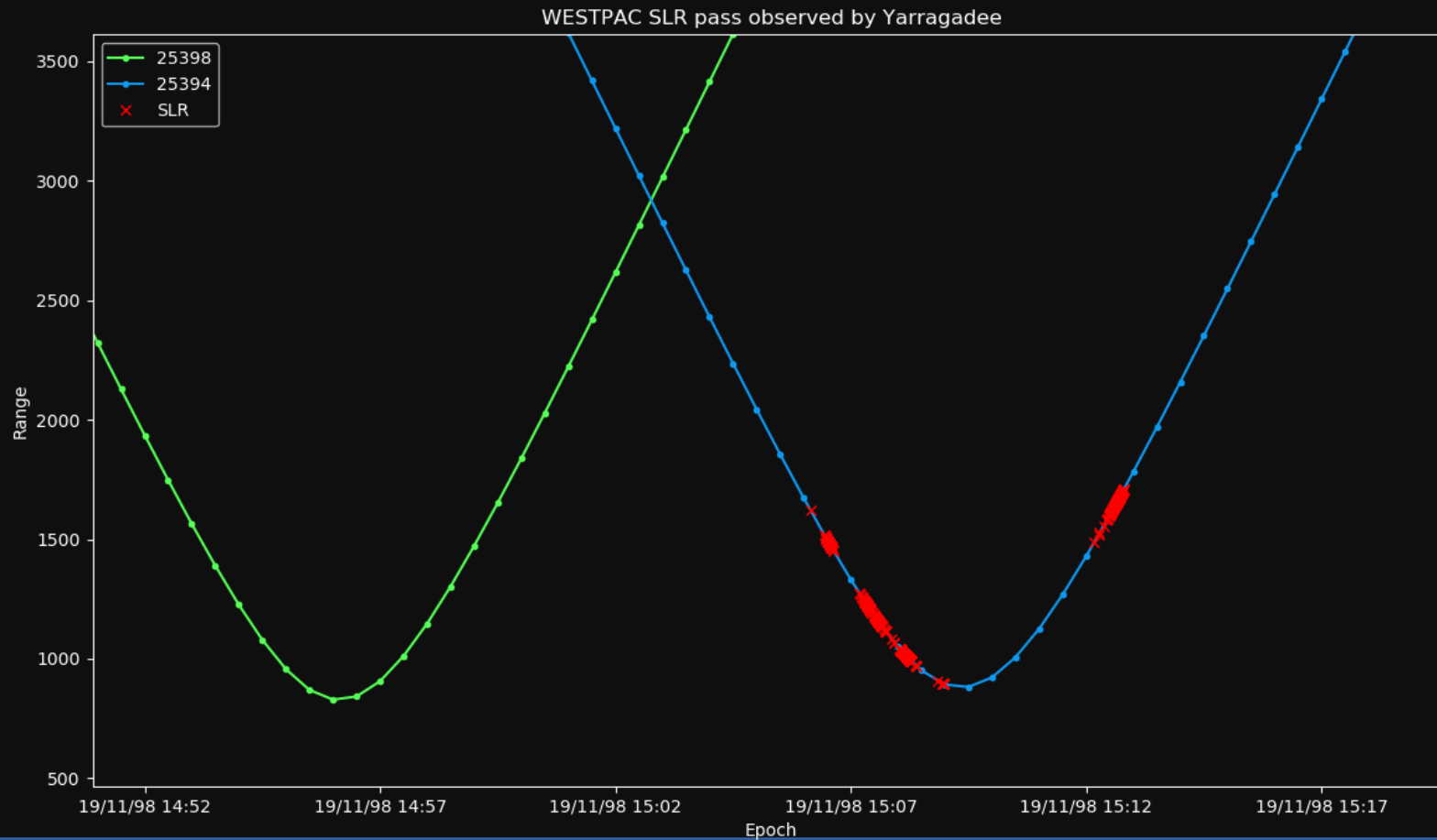
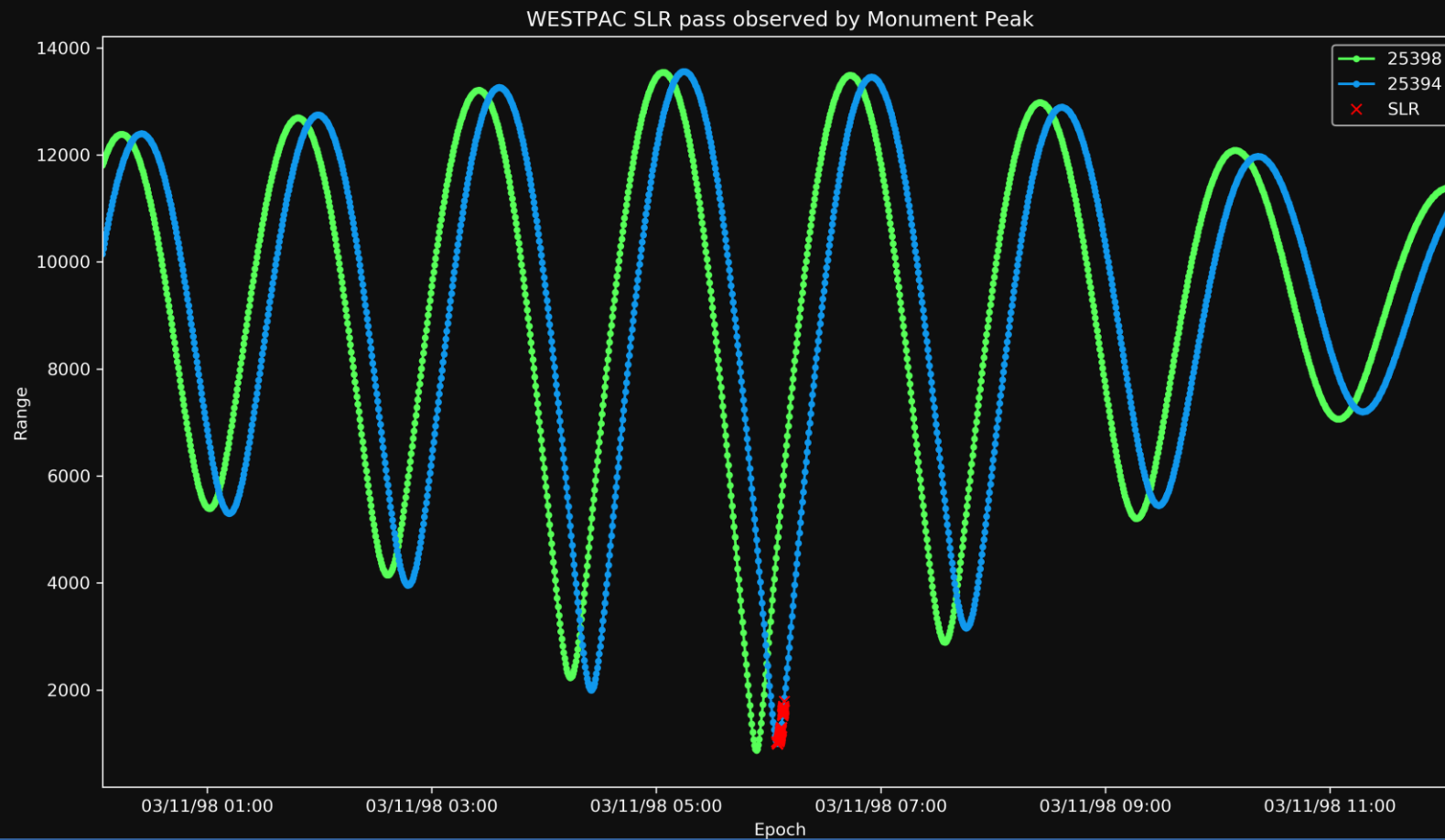The predicted TLE/CPF ranges for each station were then compared to the measured laser ranges.
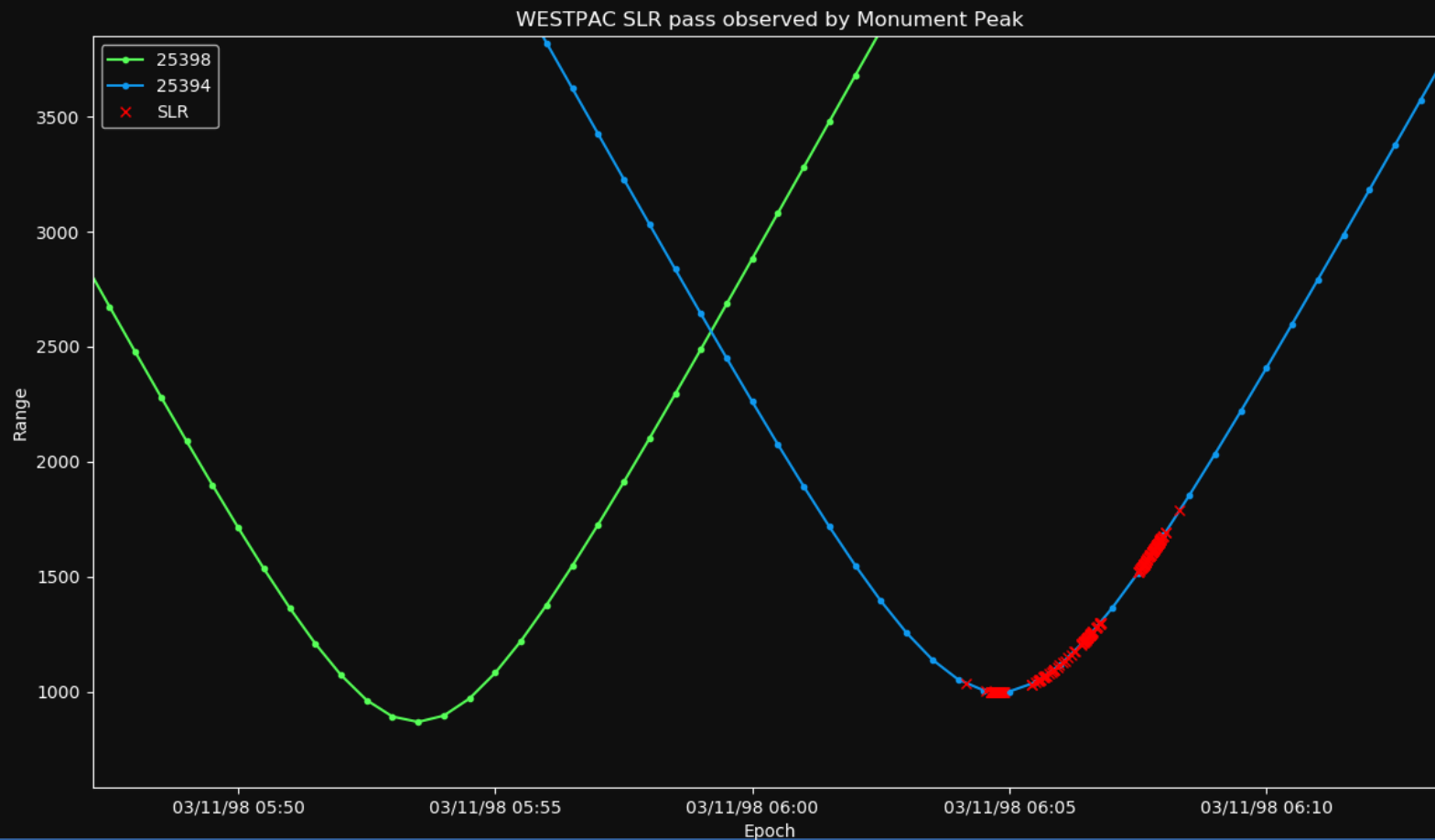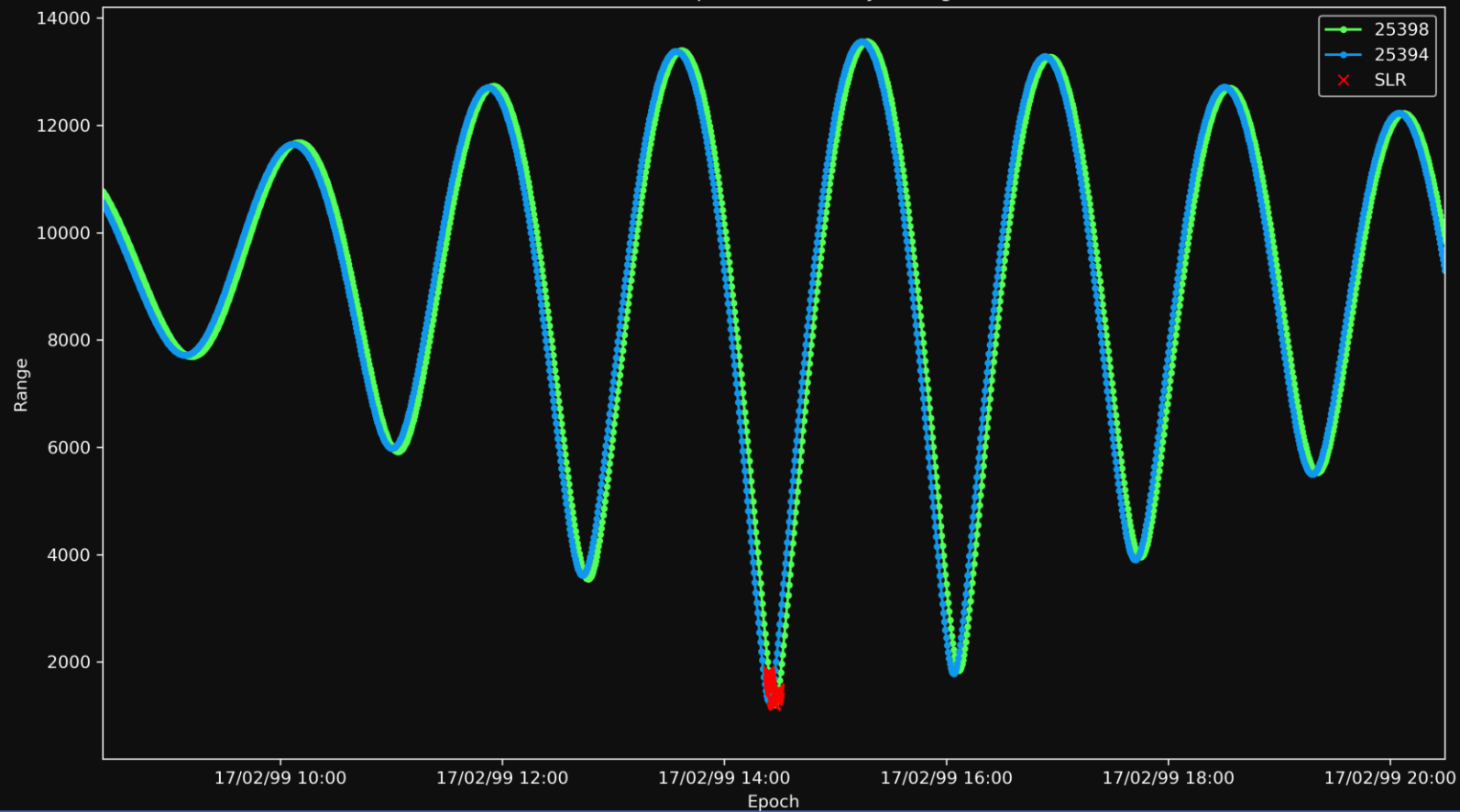
WESTPAC -NORAD

WESTPAC SLR pass observed by Yarragadee

WESTPAC -NORAD

WESTPAC SLR pass observed by Yarragadee

WESTPAC -NORAD

WESTPAC SLR pass observed by Monument Peak

WESTPAC -NORAD

WESTPAC SLR pass observed by Monument Peak

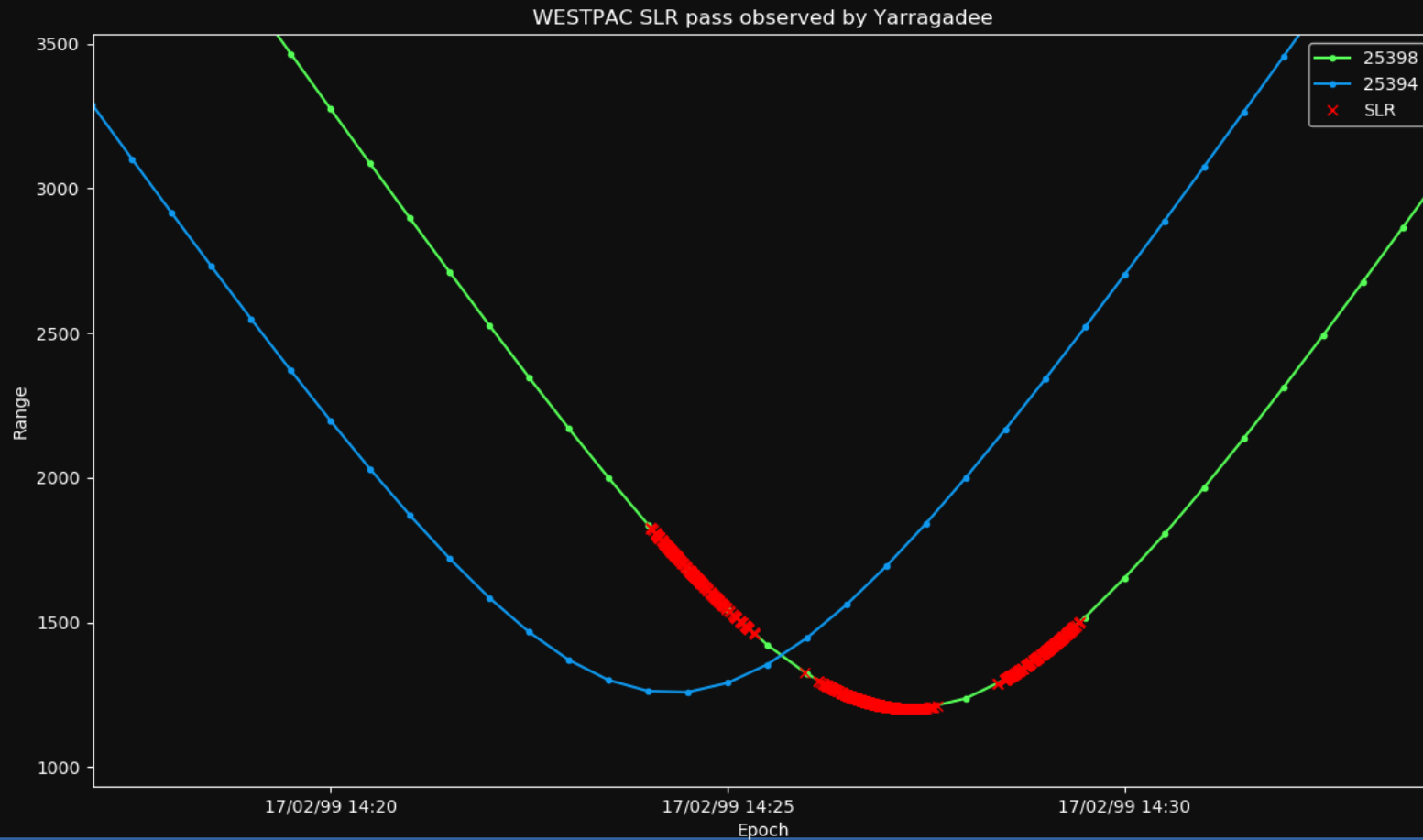# WESTPAC -NORAD

WESTPAC SLR pass observed by Yarragadee

WESTPAC -NORAD

WESTPAC SLR pass observed by Yarragadee
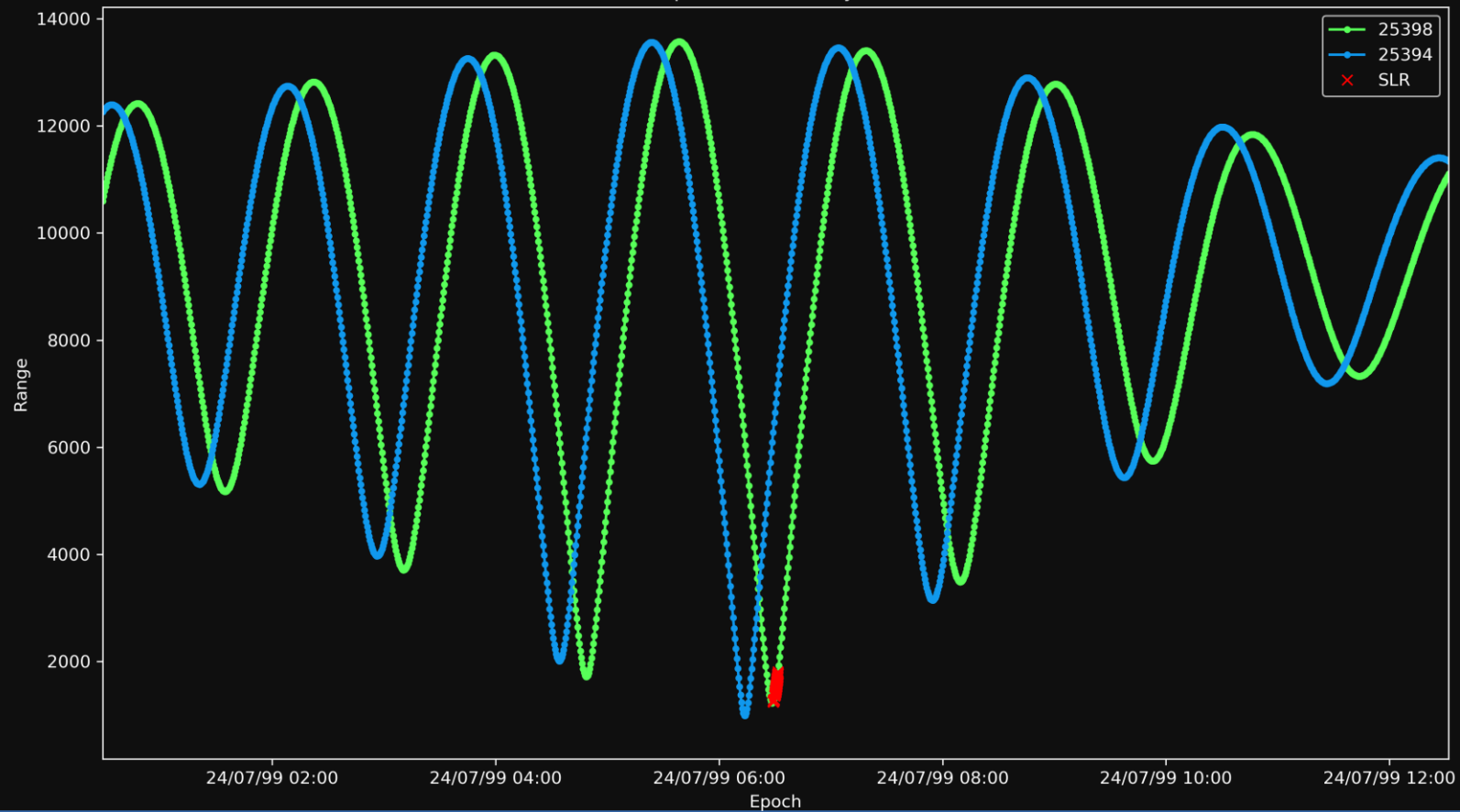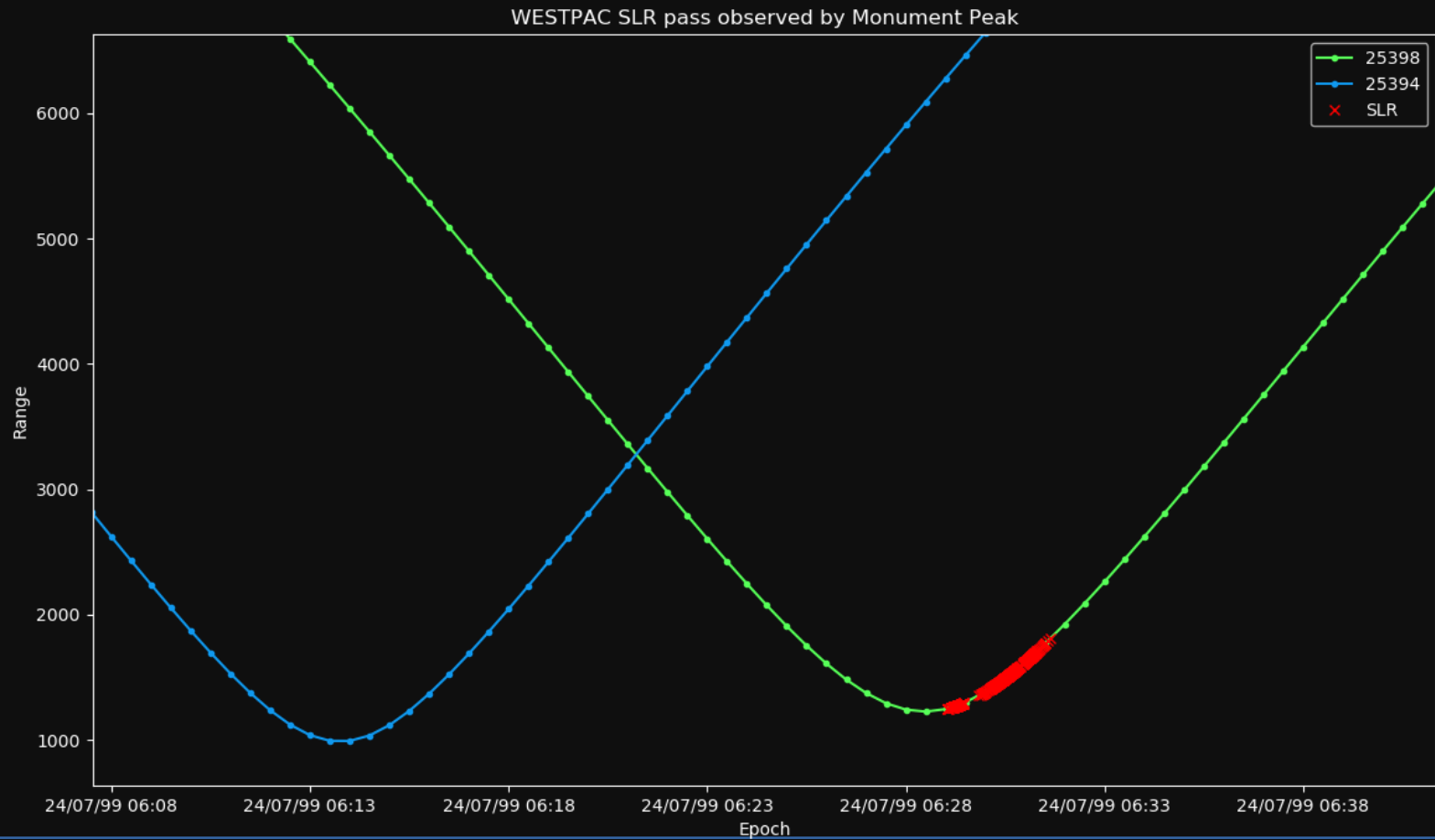
WESTPAC -NORAD

WESTPAC SLR pass observed by Monument Peak

WESTPAC -NORAD

WESTPAC SLR pass observed by Monument Peak

WESTPAC -NORAD

The WESTPAC NORAD number was 25394 but changed to 25398 in December 1998.

WESTPAC -CPFs

G. Appleby and A. Susnik worked to add WESTPAC to the set of CPF predictions routinely provided by the SGF.

Predictions have been available since May 17th.

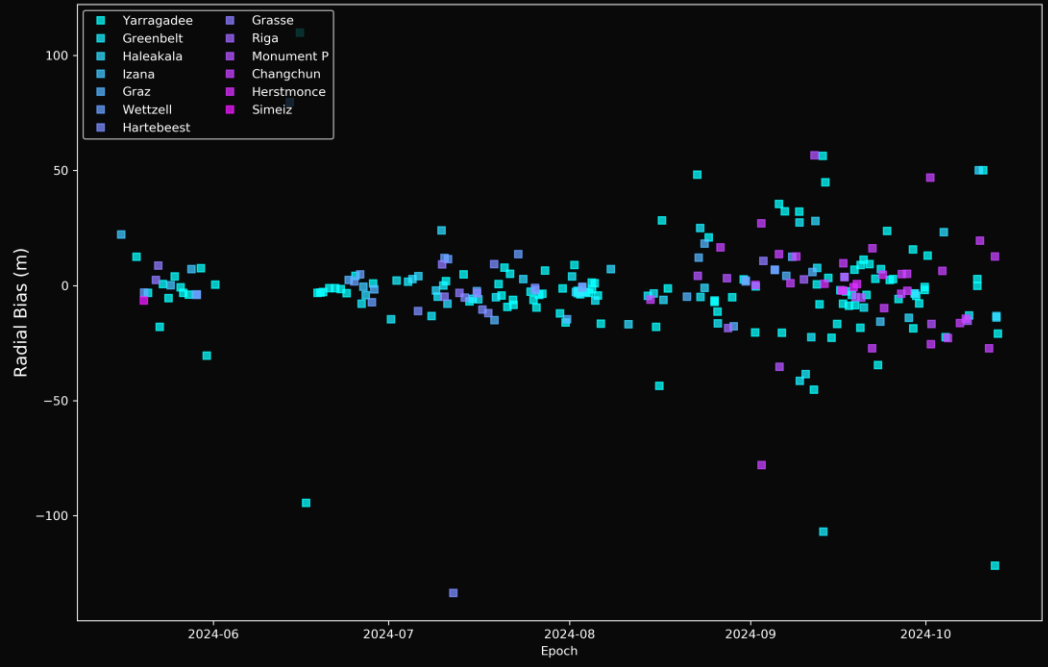The CPFs help stations to acquire WESTPAC, including in the daytime.

However, they often have a small time bias.

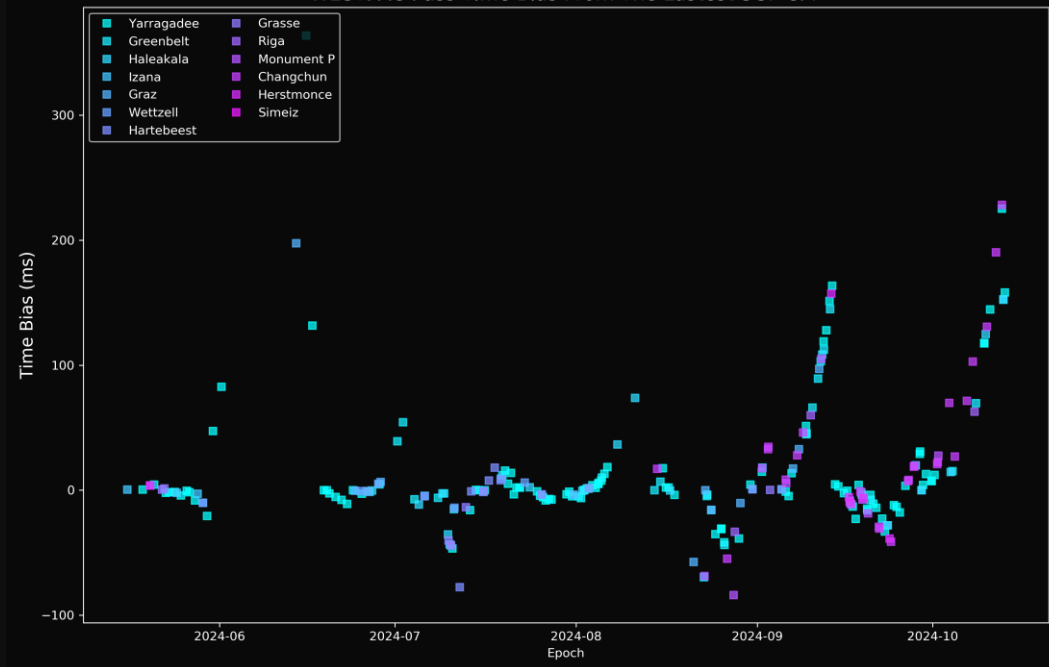This time bias can be known in advance using the DiGOS GFZ Potsdam time bias service.

[http://slr.gfz-potsdam.de:5000/tb/v1]

WESTPAC -CPFs
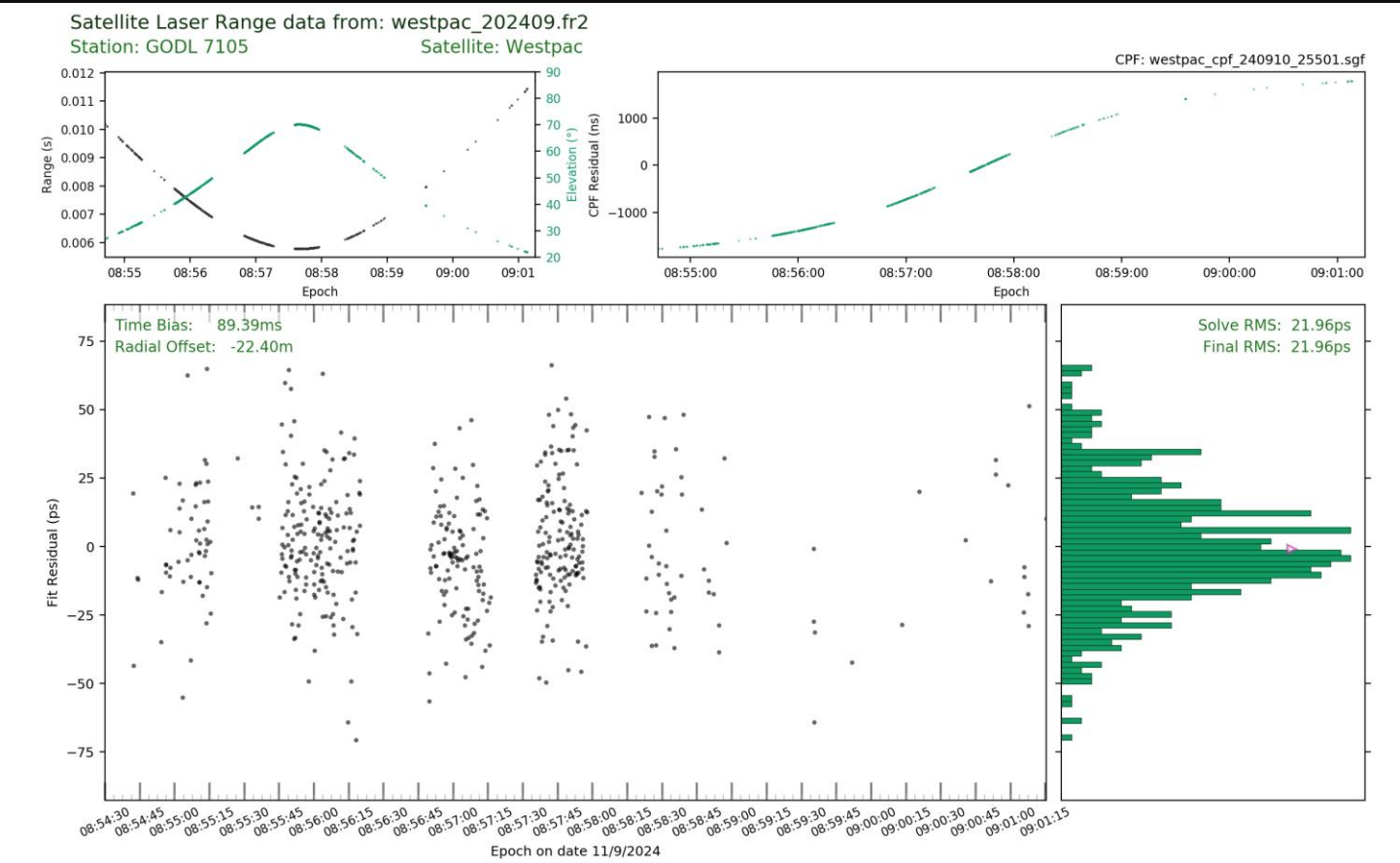
WESTPAC -SLR

Yarragadee

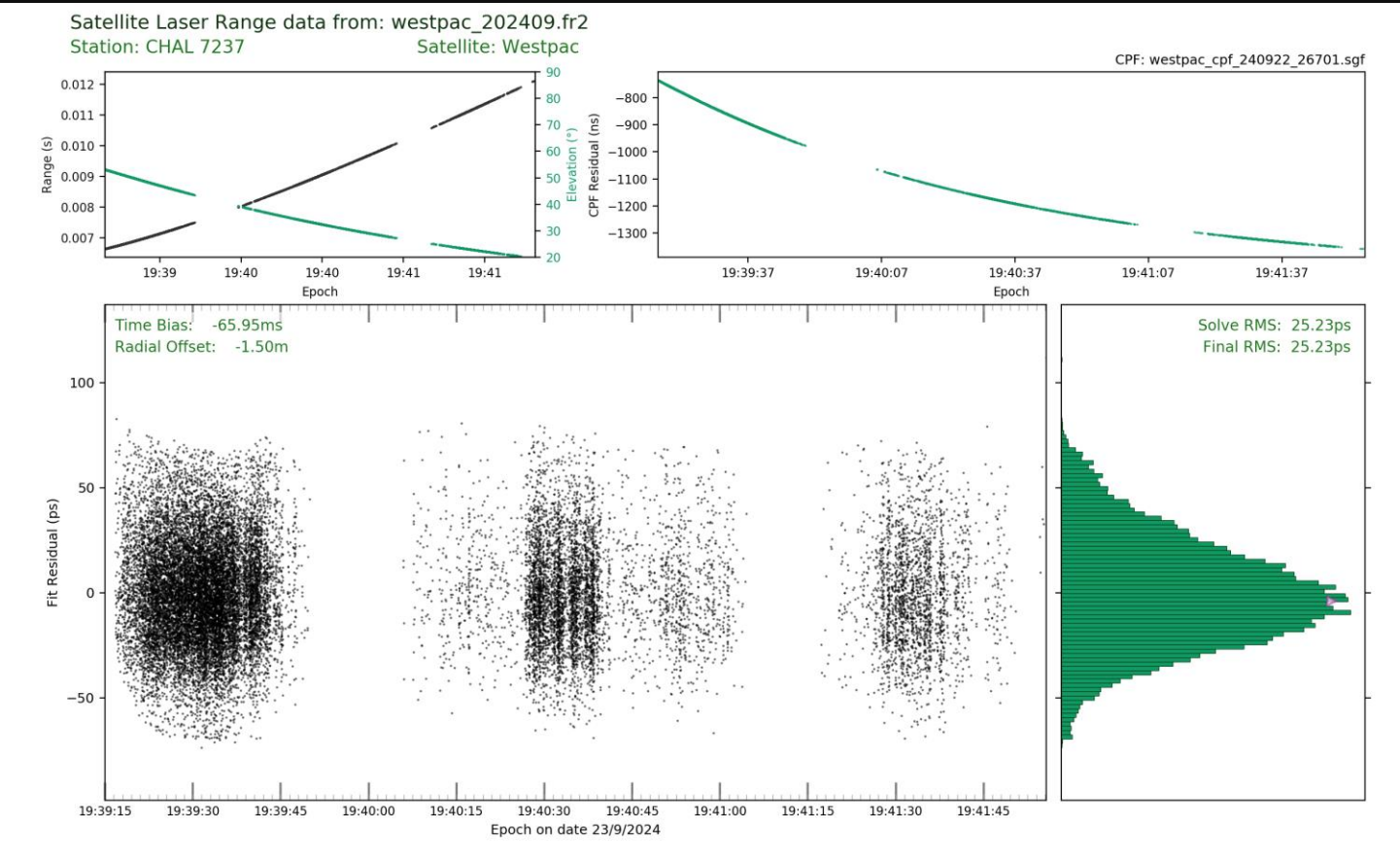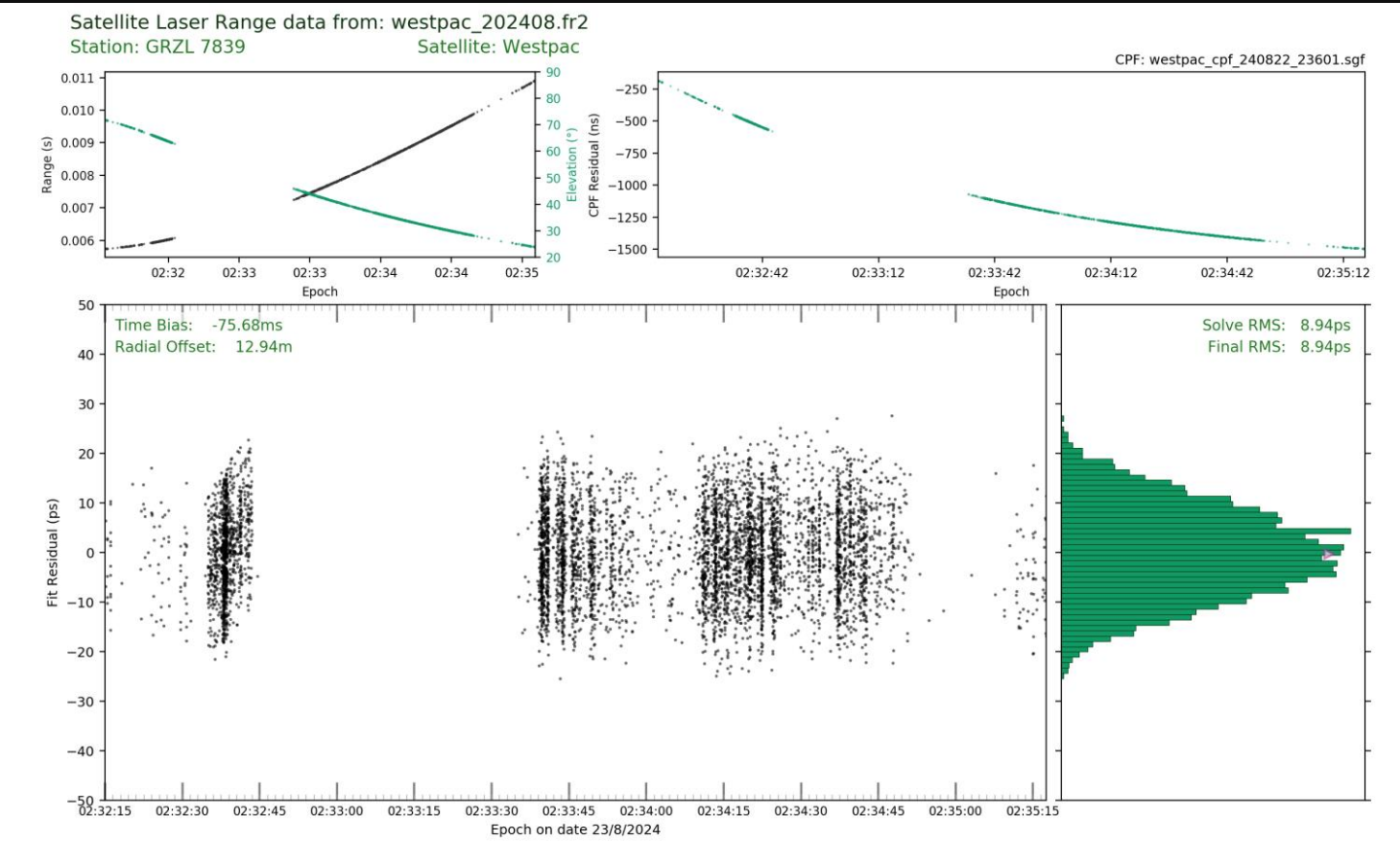WESTPAC SLR track shows characteristic periods of no data.
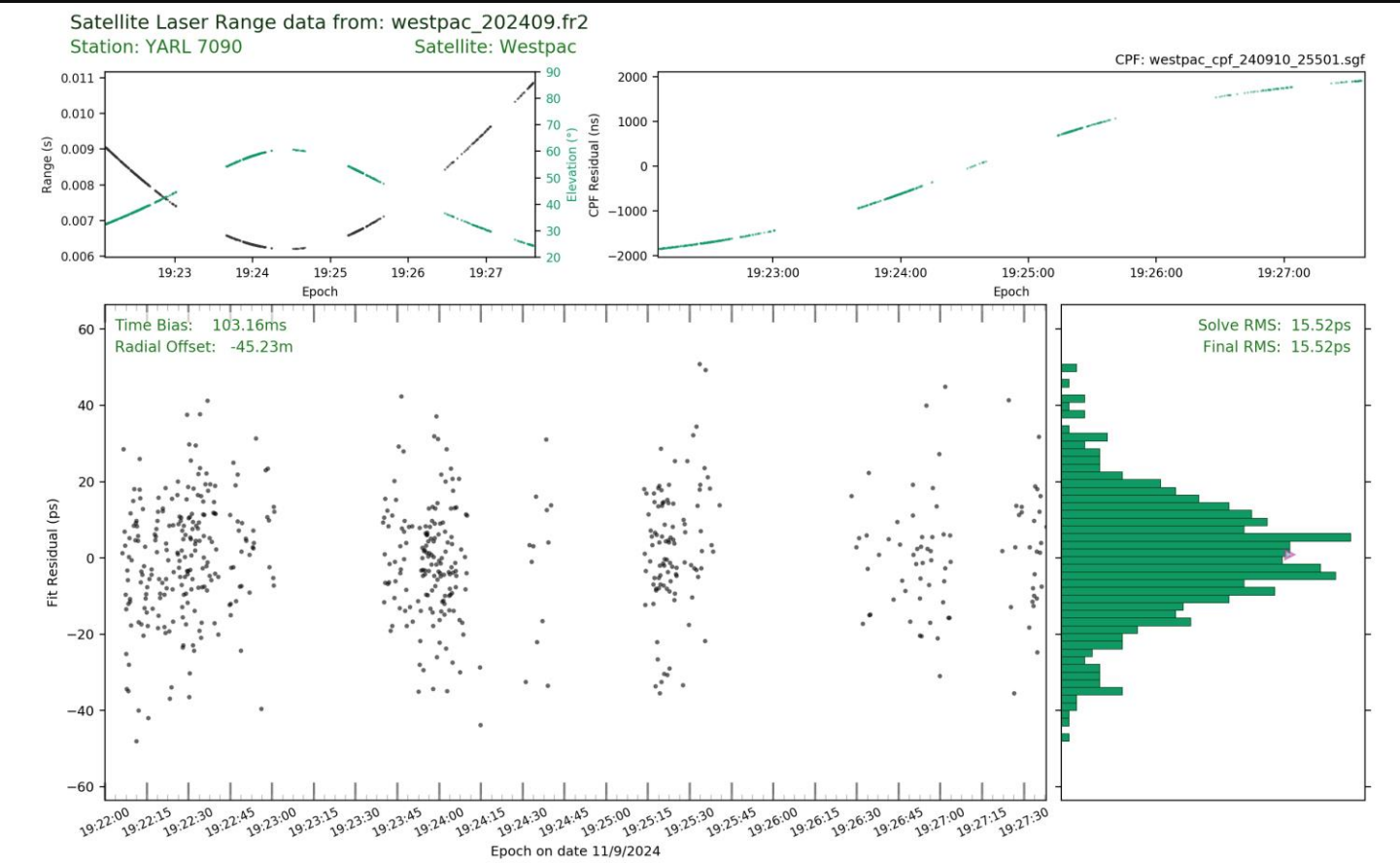
WESTPAC -SLR

Greenbelt

WESTPAC-SLR

Changchun

WESTPAC -SLR

Graz

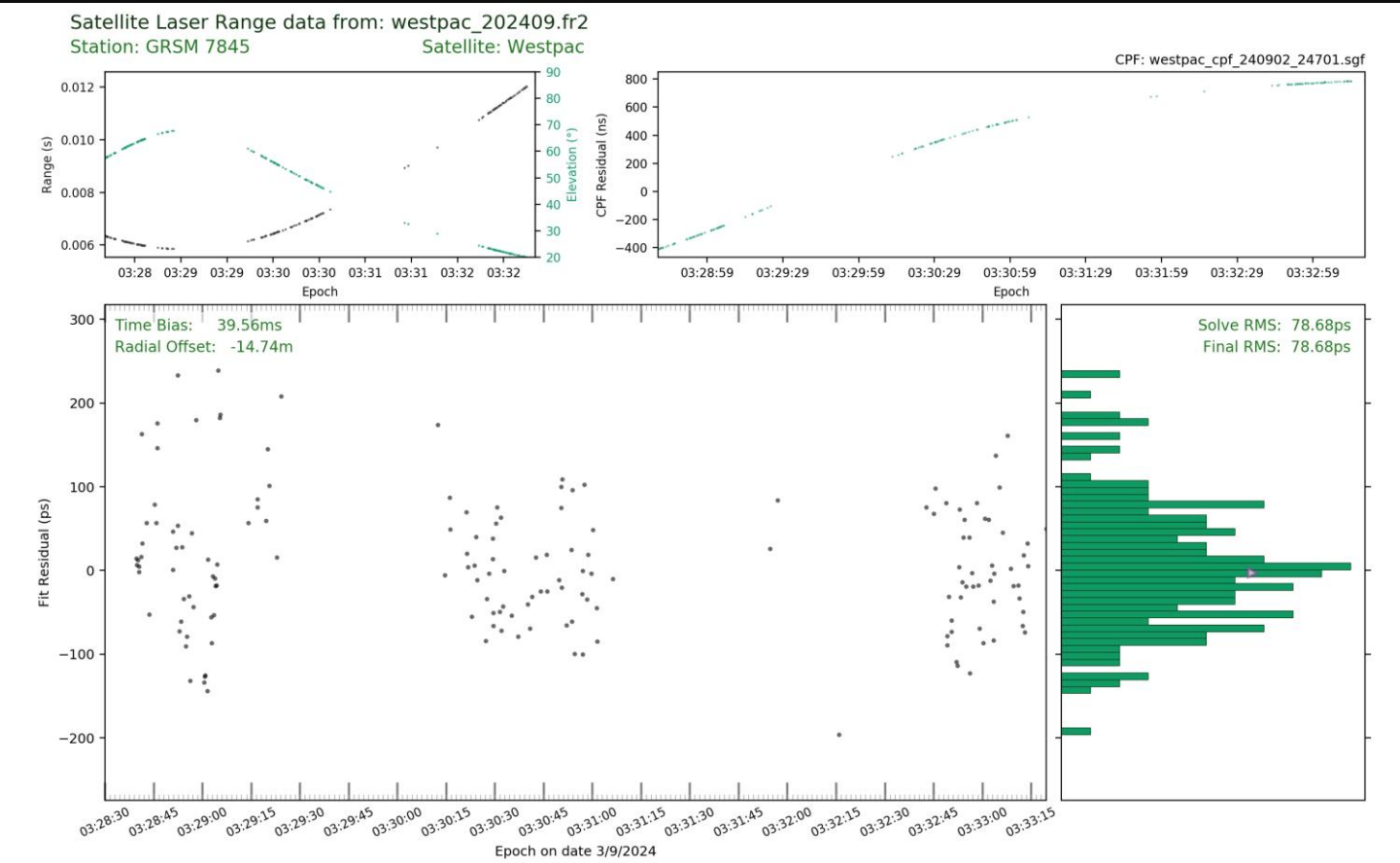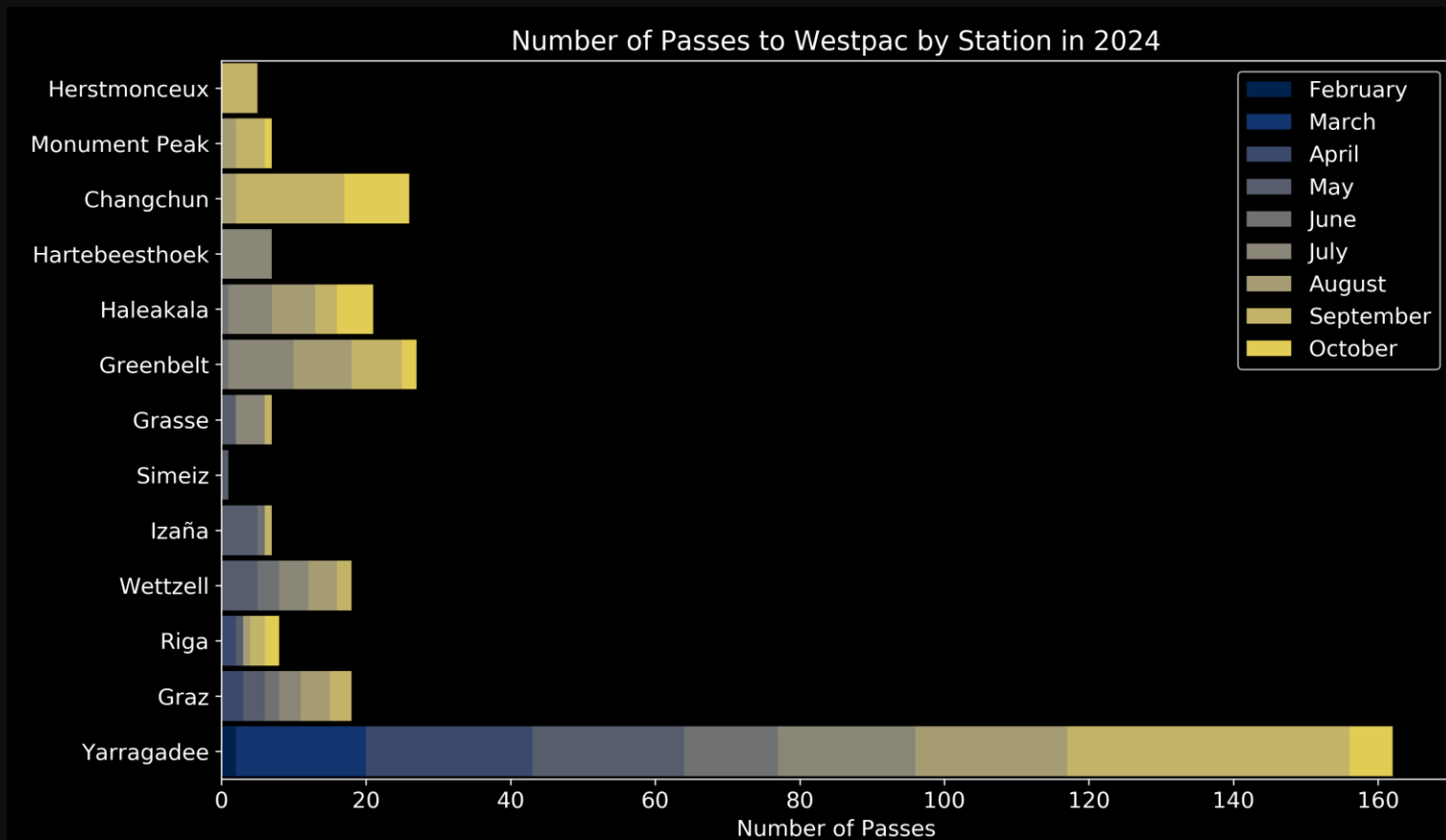# WESTPAC-SLR

Herstmonceux

Satellite Laser Range data from: westpac_202409.fr2
Station: HERL 7840   Satellite: Westpac

WESTPAC-SLR

Grasse

Satellite Laser Range data from: westpac_202409.fr2
Station: GRSM 7845   Satellite: Westpac
CPF: westpac_cpf_240902_24701.sgf

Time Bias: 39.56ms
Radial Offset: -14.74m

Solve RMS: 78.68ps
Final RMS: 78.68ps

Epoch on date 3/9/2024

WESTPAC -SLR
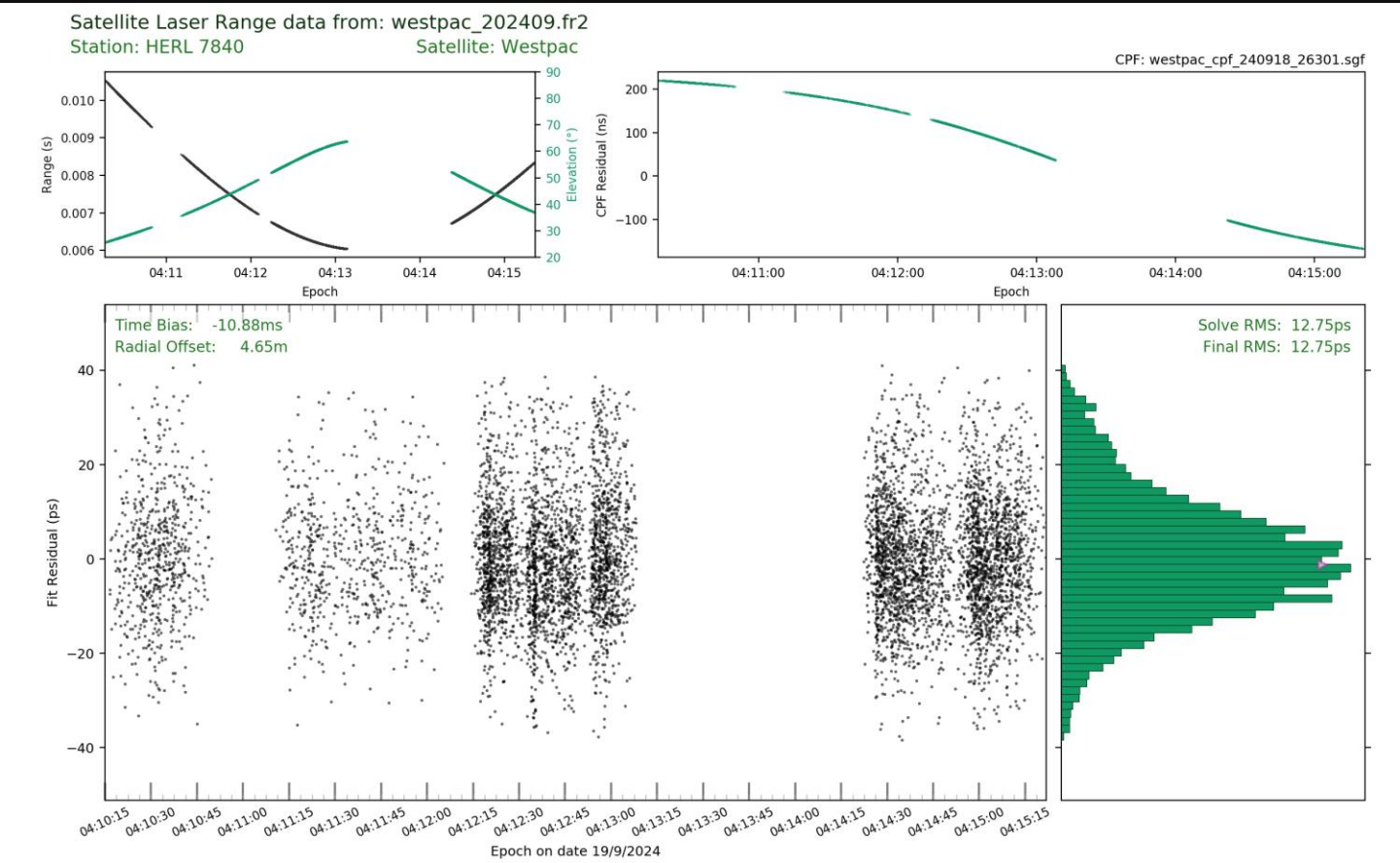
Number of Passes per station.

khz stations not showing better performance.

Number of Passes to Westpac by Station in 2024

WESTPAC -SLR

Number of
Normal Points
per station.

Number of Normal Points to Westpac by Station in 2024
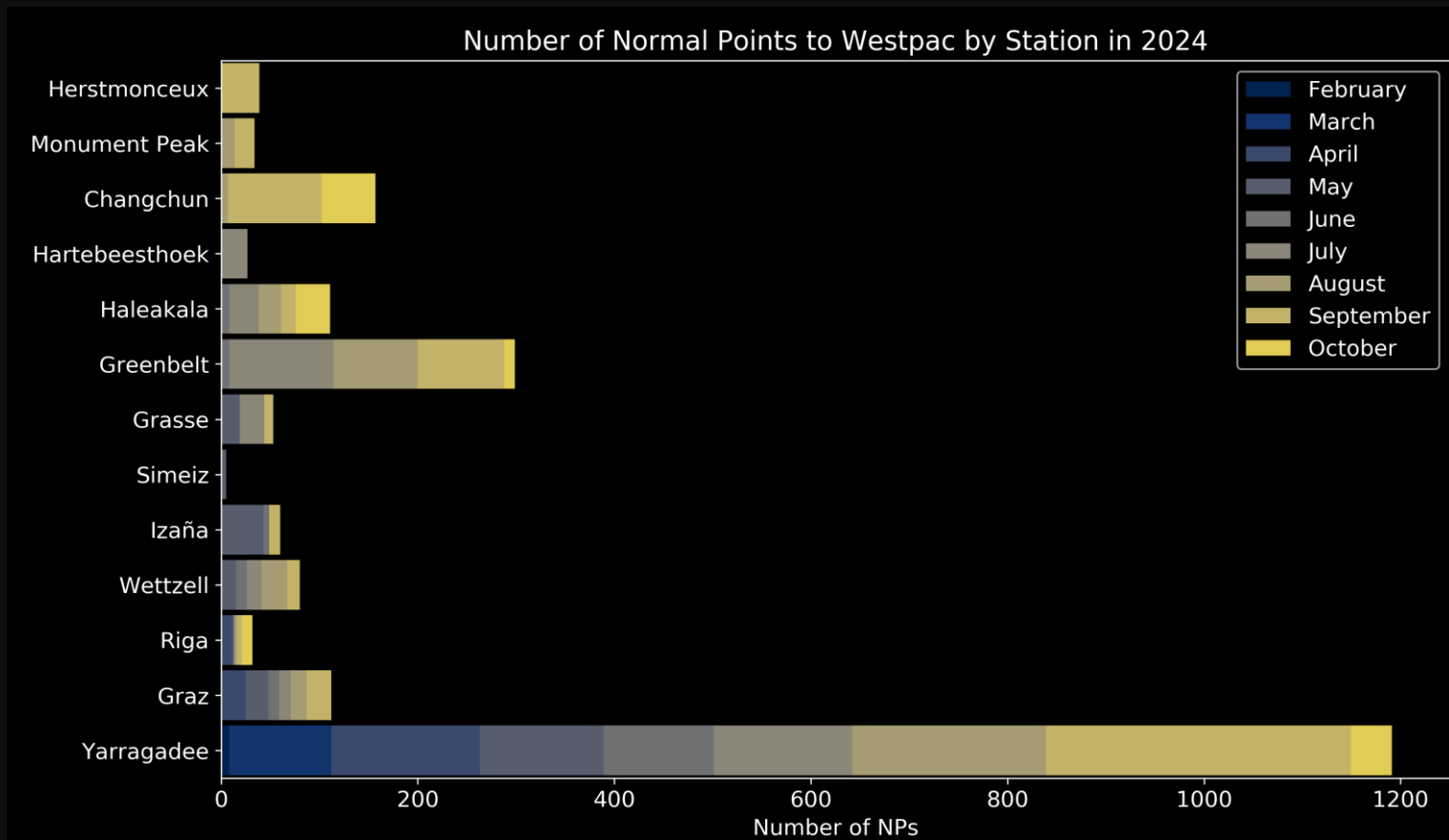
WESTPAC-SLR

Number of passes per month.

Number of Passes to Westpac by Month in 2024
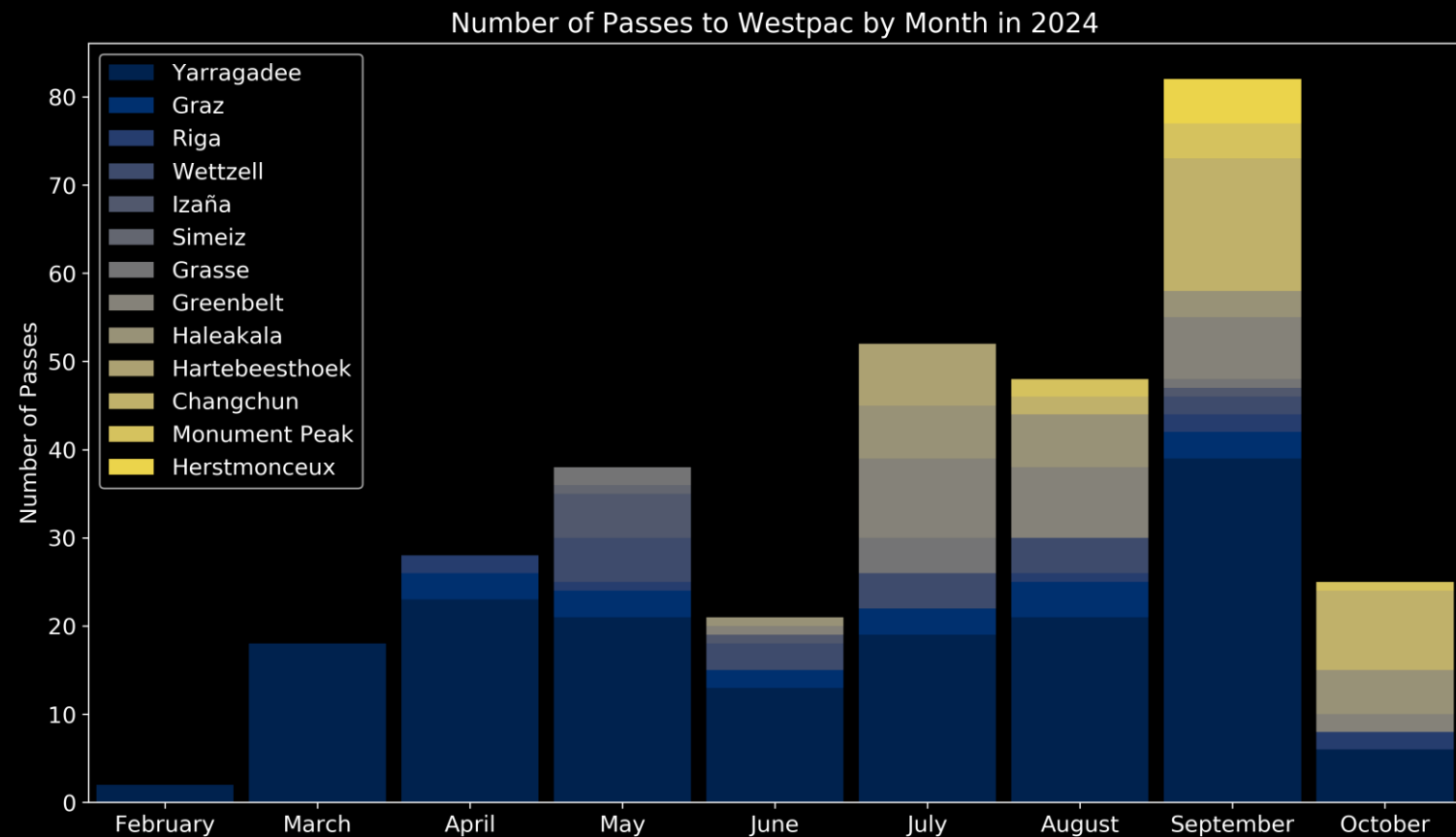
WESTPAC -SLR

Number of
Normal Points
per month.

Number of Normal Points to Westpac by Month in 2024
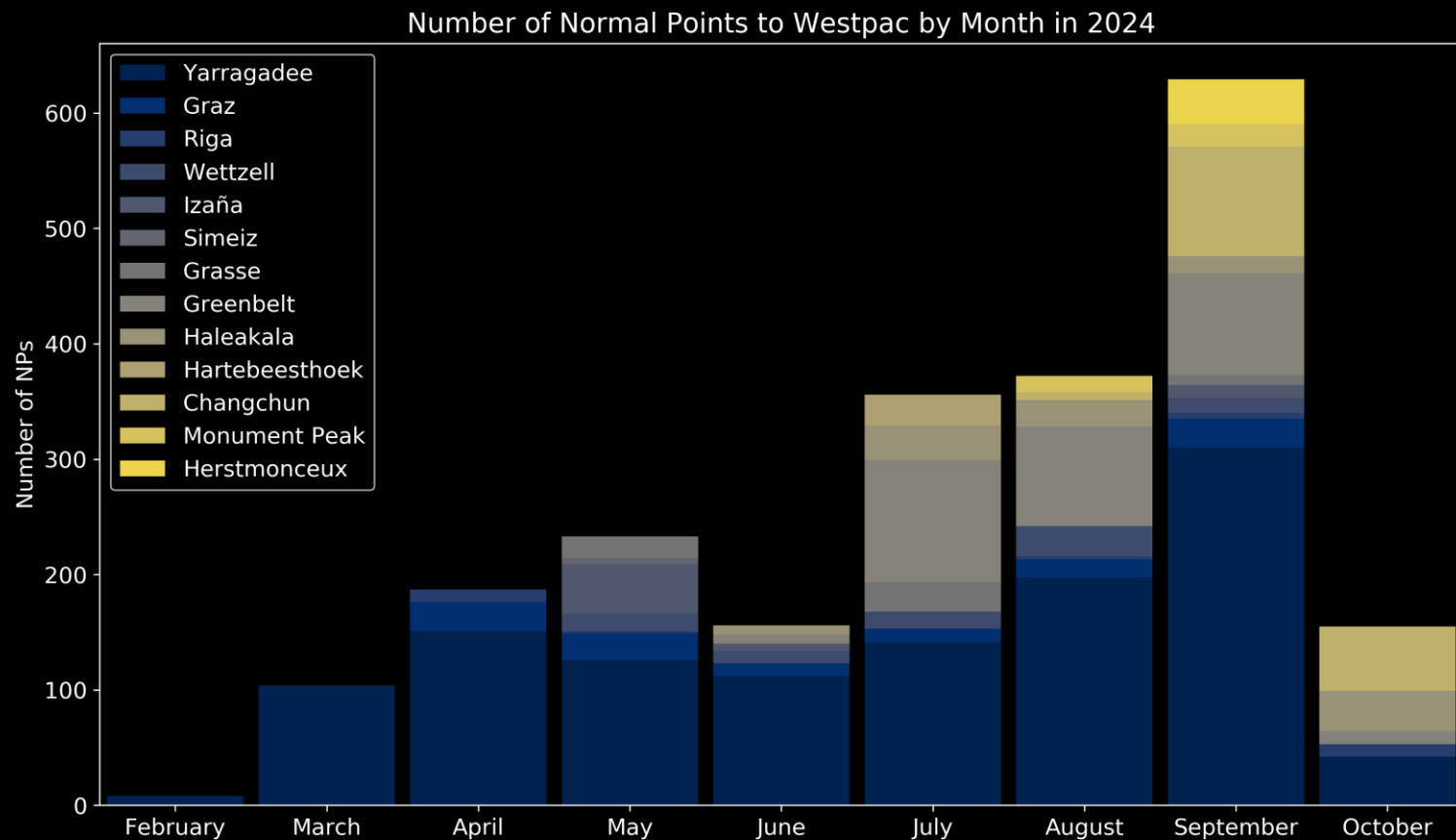
WESTPAC-SLR

Number of Normal Points at time of day.
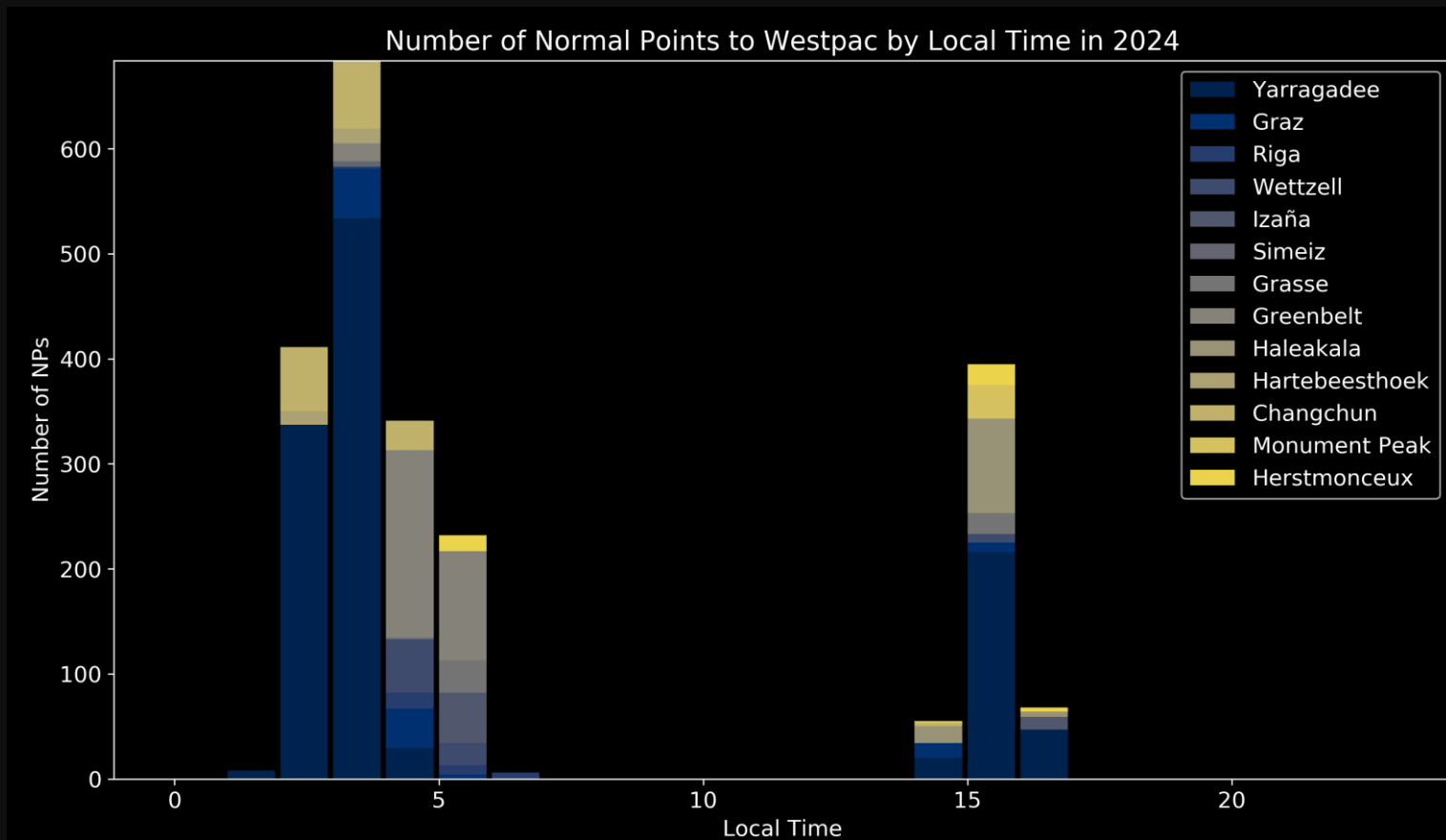
Number of Normal Points to Westpac by Local Time in 2024
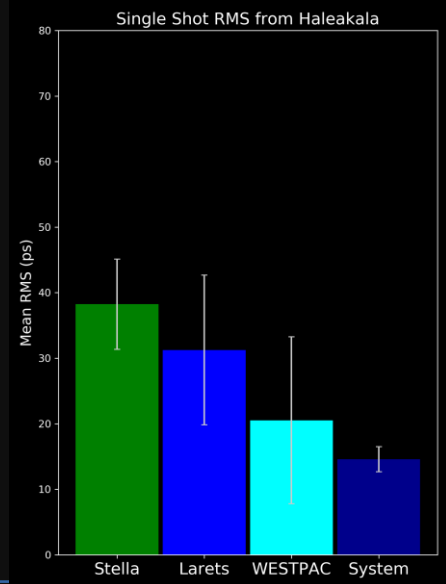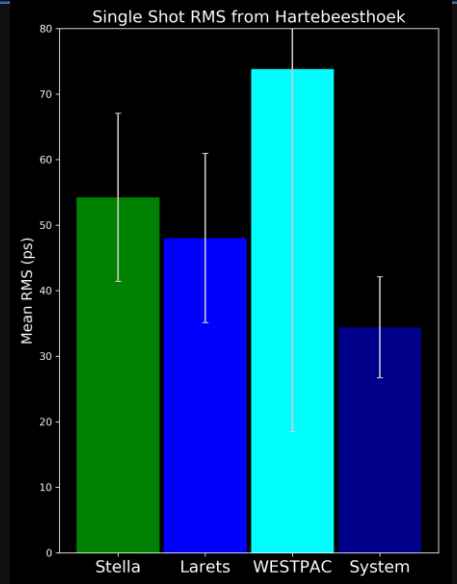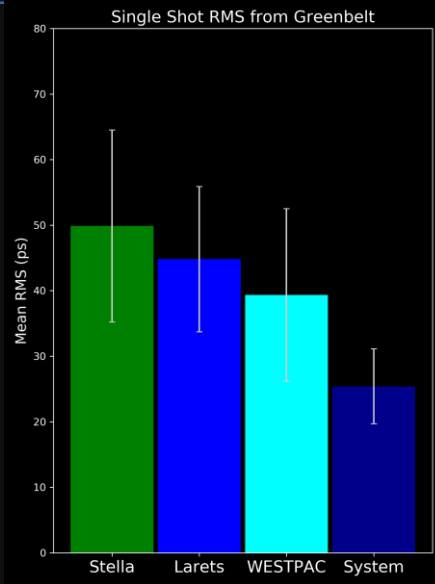
WESTPAC -SLR

Mean RMS of 2024 Normal Points for Stella, Larets and WESTPAC, including mean calibration system delay RMS.
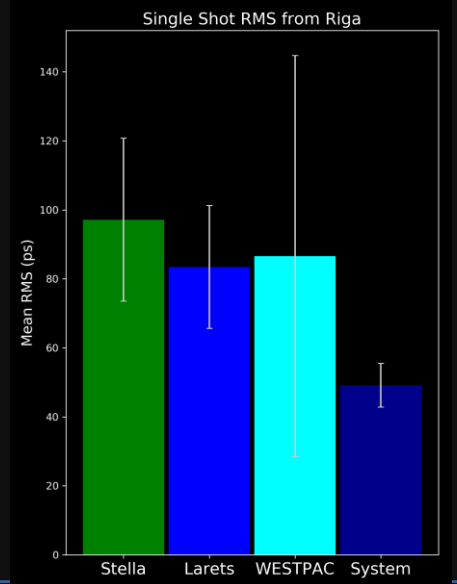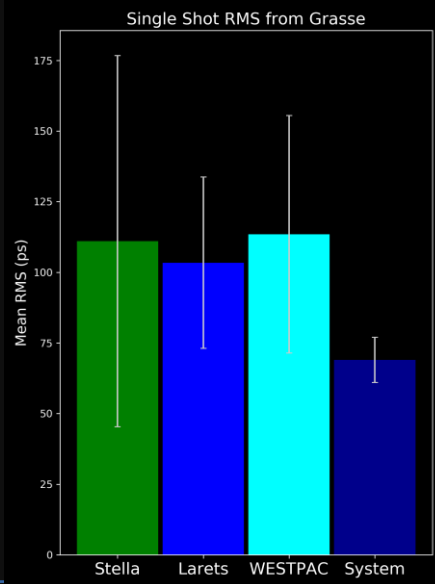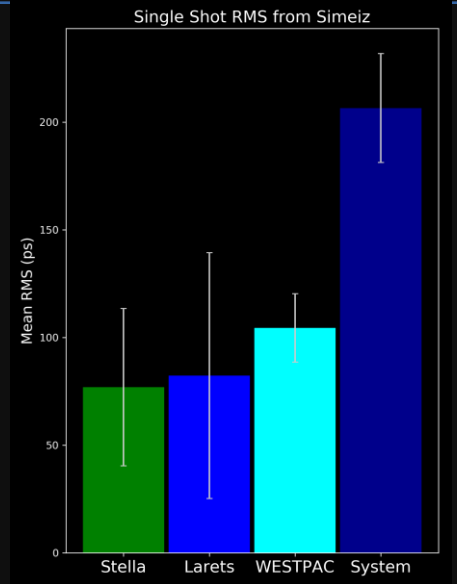
Greenbelt,
Hartebeesthoek,
Haleakala,
Monument Peak,
Yarragadee.
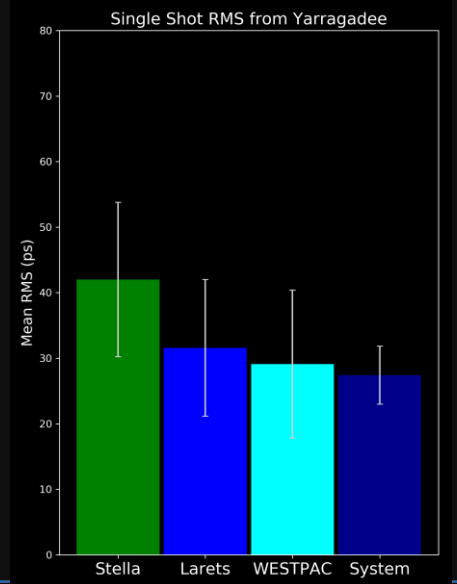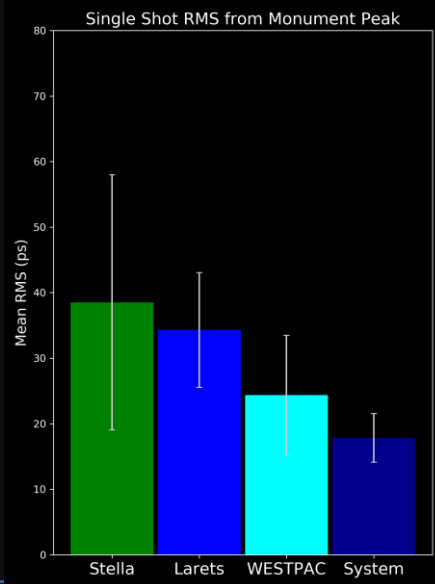
WESTPAC -SLR

Mean RMS of 2024 Normal Points for
Stella, Larets and WESTPAC, including
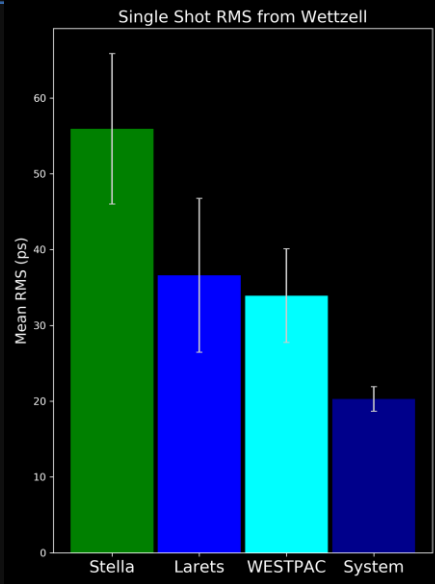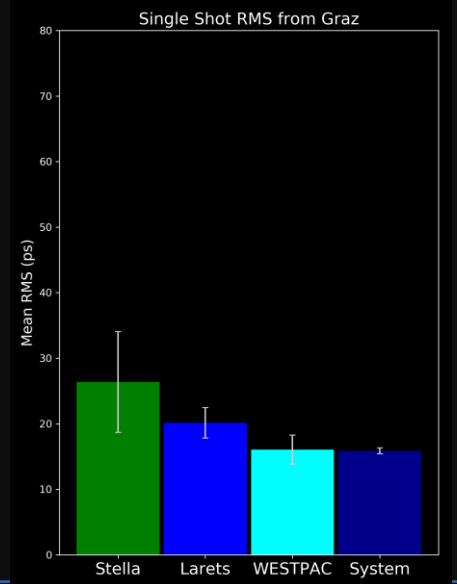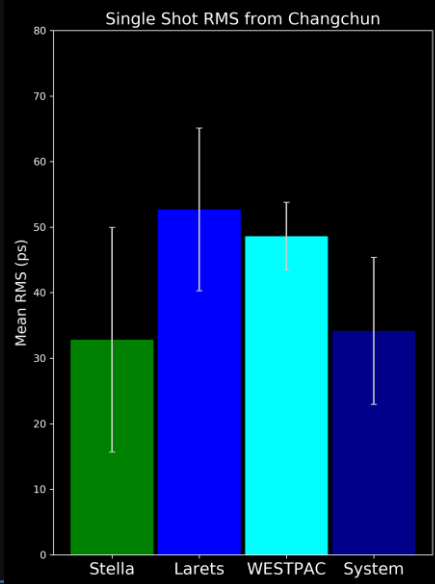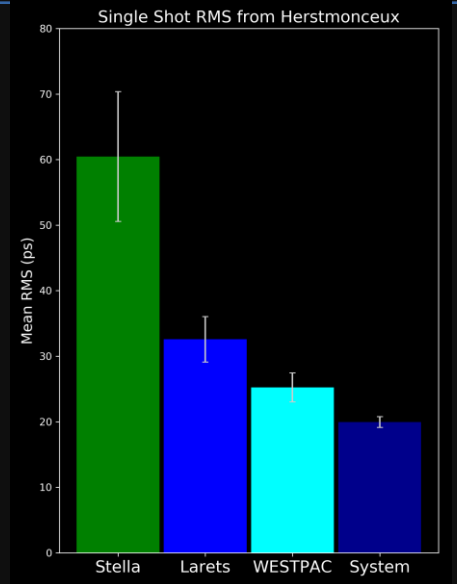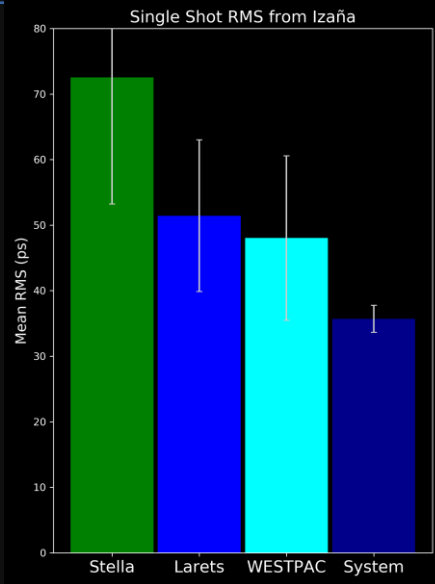mean calibration system delay RMS.

Wettzell,
Simeiz,
Riga,
Grasse.

WESTPAC -SLR

Mean RMS of 2024 Normal Points for Stella, Larets and WESTPAC, including mean calibration system delay RMS.

Izaña,
Herstmonceux,
Chanhchun,
Graz.

WESTPAC –Geodesy

WESTPAC is still a viable geodetic target.

It is in an orbit similar to Stella and so could potentially contribute to gravity field recovery.

However, it has a area to mass of 0.0015m^2/kg, which is greater than 0.00094m^2/kg for Stella, which makes it more susceptible to non-gravitational forces, such as atmospheric drag.

[Sośnica, K. Orbit design for a future geodetic satellite and gravity field recovery. J Geod 98, 77 (2024). https://doi.org/10.1007/s00190-024-01884-9]

Conclusions

The WESTPAC NORAD number change from 25394 to **25398** in December 1998.

WESTPAC has been observed successfully by SLR stations despite the intermittence of returns.

Quality CPF predictions allow daytime ranging, especially if used along with the DiGOS GFZ Potsdam time bias service.

Conclusions

Tracking WESTPAC would not represent a significant burden in the ILRS target schedule.

WESTPAC is a low satellite signature target.

We must now ask the scientific analysis community if they would be interested in this satellite returning to the ILRS priority list.

•Thank You