<http://fer3.com/arc/m2.aspx/Noon-Sun-sights-Jamestown-RI-this-Sunday-Aug-25-Stuart-aug-2013-g25027>

Below are my observations. The sights are all Sun LL and were taken on 25 August, 2013 from 41d26’56.7”N 71d23’57.7”W (i.e. **N41°26’945 W071°23’9617**). In calculating the intercepts I took the height of the eye to be 9m giving a combined correction for refraction, semi-diameter and dip of +10.1’. LAN occurred at 12h47m34s EDT (i.e.**16h47m34s UT**) around which time the Equation of Time was -1m58s. The sextant measurements along with the intercepts are EDT Hs Intercept

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **UT** | **H sext** | **Hv-He** |  | **UT** | **H sext.** | **Hv-He** |
| **1** | **16h37m37s** | **58d50.6'** | **0.2 T** | **8** | **16h53m19s** | **58d53.2'** | **0.0 T** |
| **2** | **16h40m51s** | **58d53.4'** | **0.5 T** | **9** | **16h56m56s** | **58d51.0'** | **0.4 T** |
| **3** | **16h42m40s** | **58d54.0'** | **0.2 T** | **10** | **16h58m45s** | **58d49.5'** | **0.6 T** |
| **4** | **16h45m46s** | **58d54.9'** | **0.1 T** | **11** | **17h02m53s** | **58d44.2'** | **0.5 T** |
| **5** | **16h47m47s** | **58d55.6'** | **0.7 T** | **12** | **17h08m19s** | **58d35.2'** | **0.7 T** |
| **6** | **16h49m36s** | **58d55.6'** | **0.9 T** | **13** | **17h09m48s** | **58d32.0'** | **0.5 T** |
| **7** | **16h51m15s** | **58d54.6'** | **0.4 T** | ***14*** | ***16h33m35s*** | ***58d47.6'*** | ***1.7 T*** |

Clearly from the intercept the first observation is a bit of an outlier.
The sights are plotted in the attached image with the least squares fit to a parabola. It is also possible to fit to the usual altitude formula but in this case it doesn’t make much difference in the accuracy of the fix. It might however make a significant difference when the attitude of the Sun is much higher and a simple parabola is not a good fit.

Working from the single maximum altitude alone yields a latitude of 41d26.2’ in error by 0.7nm. Using the time and maximum altitude obtained from the fit gives a position of 41d26.5’N 71d17.9’W which is an error of 0.4nm in latitude and 4.5nm in longitude. If the first observation in the series is excluded the longitude from the fit becomes 71d23.3’W which has an error of just 0.5nm! Fluke?

Robin Stuart

**Antoine M. “Kermit” Couëtte’s RESULTS (*HP41CY ASTRONAV SOFTWARE*)**

*With combined height corrections very close from +10.00’ (vs. +10.1’ used by Stuart)*

**TT-UT = +68.4s with Observations 1 to 14 *True Position 0’5 North and 1.1’ West from Computed Pos.***

**SUN LTT = 12h47m29.5s \*\*\* OBS LAT=N 41:26.4 \*\*\* OBS LON=W 071:22.9 \*\*\* √(σ[d2/n])=0.4 NM \*\*\***

**VALID+/-0.43 h.mm around Culmination Time \*\*\* Valid UT SPAN (16.04-17.30) \*\*\***

**e.T’ / e.H’ ≤ 3.9 \*\*\* 1σ EST LAT ERR 0.4’ \*\*\* 1σ EST LON ERR 1.5’ \*\*\* ΔT culmination-transit = -9.2s**

**TT-UT = +68.4s with Observations 1 to 13 *True Position 0’3 North and 1.4’ East from Computed Pos.***

**SUN LTT = 12h47m39.5s \*\*\* OBS LAT=N 41:26.6 \*\*\* OBS LON=W 071:25.4 \*\*\* √(σ[d2/n])=0.3 NM \*\*\***

**VALID+/-0.43 h.mm around Culmination Time \*\*\* Valid UT SPAN (16.04-17.30) \*\*\***

**e.T’ / e.H’ ≤ 3.9 \*\*\* 1σ EST LAT ERR 0.3’ 1σ \*\*\* 1σ EST LON ERR 1.0’ \*\*\* ΔT culmination-transit = -9.2s**

<http://fer3.com/arc/m2.aspx/Noon-Sun-sights-Jamestown-RI-this-Sunday-Aug-25-Stuart-sep-2013-g25042>

In order answer the question of the likelihood of getting 0.5nm accuracy from a series of Sun sights around LAN I set up a Monte Carlo simulation of 10,000 trials in Excel using the 14 observation times listed in the earlier post. The true altitude was calculated in the usual way, taking into account the d = -0.9’ per hour change in declination of the Sun, and a normally distributed random error was added to each value. The standard deviation was 0.26’ which is the standard deviation intercepts in the actual observations when the first (outlier) observation is excluded. The maximum was found by least squares fit to a parabola. The results are shown in the attached histogram. The x-axis units are seconds with t = 0 representing LAN. The offset of the peak the distribution arises from the Sun’s changing declination ( http://fer3.com/arc/imgx/v32n1-6.pdf ) and amounts to 9.6 seconds. I had ignored this effect in when calculating longitude previously but since we are approaching the equinox d is getting close to its maximum. Including it chances things a bit. Error in longitude including all sights: 2.7nm Error in longitude excluding 1st sight (outlier): 1.3nm

The results of the Monte Carlo can be used to produce a probability distribution for the error in determining the time of maximum altitude and hence the error in longitude. The plots are attached. There was about a 10% chance of determining longitude with an error of 0.5nm or less, even odds of better than 1.75nm and 95% probability of doing better than 3.5nm. These figures will depend on the number and spacing of the sights and the standard deviation of the altitude measurements.

Robin Stuart

