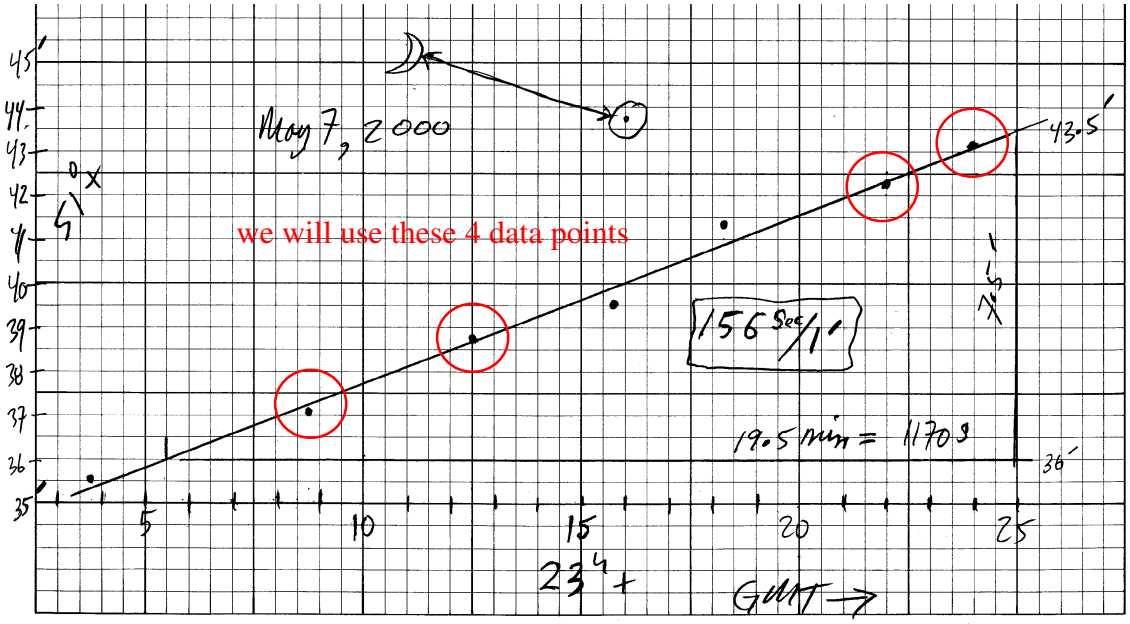
Lunar Distance with the StarPath StarPilot (see www.starpath.com)

Due to its own orbital motion around the earth, the apparent position of the moon among the stars changes daily. It circles the earth in about 30 days so the rate is 360°/30day = about 12° per day. If the moon is next to the star Aldebaran one night at 10 pm say, then the next night at 10 pm it will be about 12° to the east of the star.

Moving at 12°/day, we can figure its hourly rate as: 12 x60'/24hr = 30'/hr — it can actually be a bit faster than this since its period is closer to 28 days than to 30 days, or in practice rather slower than this if the reference body is not in line with the moon's motion. We can express this another way as the number of seconds it takes the lunar distance to change by 1' — ie, 1hr/30' = 3600sec/30' = 120 seconds per 1' of lunar distance. This can get as low as about 112seconds per 1' but this is the limit we are dealing with. If our sight is wrong by 1', the GMT we figure from it will be wrong by at least 112 seconds. Hence the best we can hope to do in ideal conditions is about 1 minute of time accuracy.

Here is some real data from May 7, 2000 (times in GMT)
Temp = 52°F, pressure = 1017 mb, elevation = 62 feet, IC = 0.0', Location = 47.405 N, 122.239 W

GMT	Ds (lunar distance straight from sextant)
23.0349	51.360
23.0843	51.376
23.1230	51.392
23.1542	51.400
23.1815	51.418
23.2158	51.427
23.2400	51.436



Writing all angles as ddd.mmm (ie 45° 23.45' = 45.2345) and times as hh.mmss in UT

May 7, 00	Moon (GHA,dec)	Sun (GHA,dec)	Separation
23.0000	110.454, N21.341	165.527, N17.060	3116.87' = 51.5687
24.0000	125.087, N21.345	180.528, N17.067	3150.73' = 52.3073 = 33.9'/hr = 106s/1'

If your watch is fast, your longitude determination will be too far to the west. For example, if i am at 122.239 and do a noon sight for longitude on may 7th, the sun would cross by me at 20.0604, but if my watch was 14 minutes fast, it would read 20.2004 when the sun was on the meridian. Then when i go into the almanac to find my longitude (ie the GHA of the sun at 20.2004) i would find 125° 53.9' which is 3° 30' to the west (ie 14m x 15'/1m = 210' = 3.5°).

So let us assume that we have done this (ie we found an accurate latitude, we don't need time for that, and we found an erroneous longitude 125.539 from our erroneous watch time which is 14 minutes fast.

Now let's apply our lunar distance measurements to see if we can learn what the watch error is? That is, we will add 14 minutes to each of the sights, and then clear the lunar distances from the erroneous position to see if they tell us what the watch error was.

IC = 0, HE = 62, DR lat = 47.40, DR lon = 125.54, T= 52F, P = 1017

GMT (+error)	Ds	
23.1749	51.360	
23.2243	51.376	21m 06s Fast
23.2630	51.392	20m 49s Fast
23.2942	51.400	
23.3215	51.418	
23.3558	51.427	21m 23s Fast
23.3800	51.436	21m 08s Fast

So far it looks like the watch error is about 21 min fast (but we are not done yet)... average these using StarPilot avg time function to get a mean value of 21m 07s. Then reduce the times by this amount, adjust the Lon to the east by this amount (21m 7s = 21*15' = 315' = 5° 15') and redo the lunar reductions:

IC = 0, HE = 62, DR lat = 47.40, DR lon = 120.39, T= 52F, P = 1017

GMT (+error)	Ds	
23.0136	51.376	09m 49s Slow
23.0523	51.392	10m 07s Slow
23.1451	51.427	09m 34s Slow
23.1653	51.436	09m 50s Slow avg of the 4 = 09m 50s

add this to times, move lon back to the west by 10x15 or 150' = 2° 30'

IC = 0, HE = 62, DR lat = 47.40, DR lon = 123.09, T= 52F, P = 1017

GMT (+error)	Ds	
23.1126	51.376	04m 40s Fast
23.0613	51.392	
23.2441	51.427	
23.2643	51.436	04m 40s Fast = 70’ of lon = 1° 10’

move lon back to the east by 1.10 or 121.59 and subtract 4m 40 sec from the times and do it again!

IC = 0, HE = 62, DR lat = 47.40, DR lon = 121.59, T= 52F, P = 1017

GMT (+error)	Ds	
(2) 23.0646	51.376	2m 10s Slow
(7) 23.2203	51.436	2m 10s Slow

move lon to the west by 32’ or new lon = 122.31 and add the new error -- we are getting close!

DR lat = 47.40, DR lon = 122.31

GMT (+error)	Ds	
(2) 23.0856	51.376	1m 0s Fast
(7) 23.2413	51.436	

lon to the east by 15’ to 122.16 and subtract 1m from times.

DR lat = 47.40, DR lon = 122.16

GMT (+error)	Ds	
(2) 23.0756	51.376	0m 28s Slow

28s = 28/60 x 15’ = 7’ or new lon = 122.23 (we are home!)

DR lat = 47.40, DR lon = 122.23

GMT (+error)	Ds	
(2) 23.0824	51.376	0m 13s Fast = 3’ of lon

DR lat = 47.40, DR lon = 122.20

GMT (+error)	Ds	
(2) 23.0811	51.376	0m 6s Slow.... ie we call it 3 and quit

final = 23.0814 and the actual was 23.0843 or we found GMT to within 29 seconds and our longitude to within about 4’