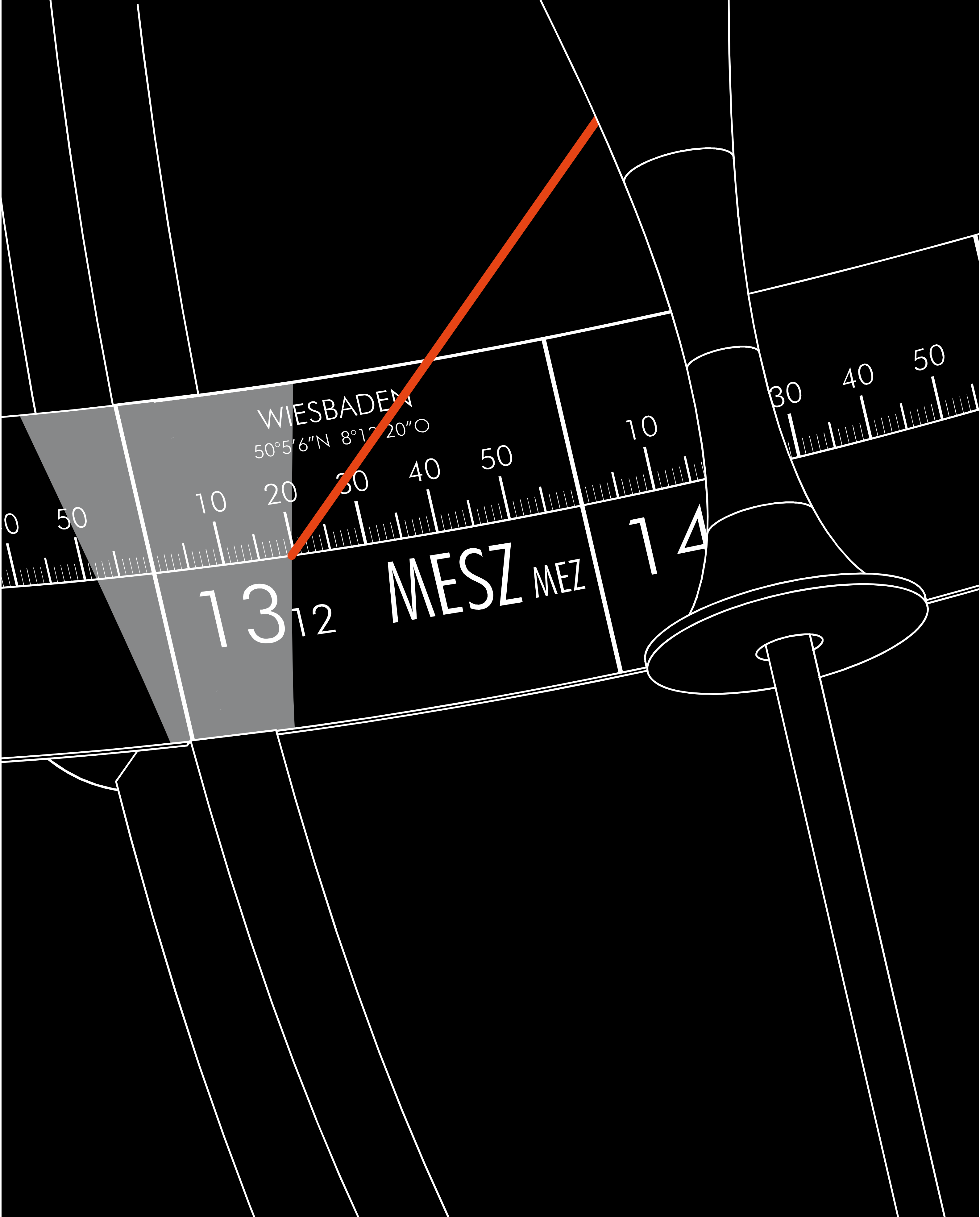
CHRONOS
MANUAL



Contents

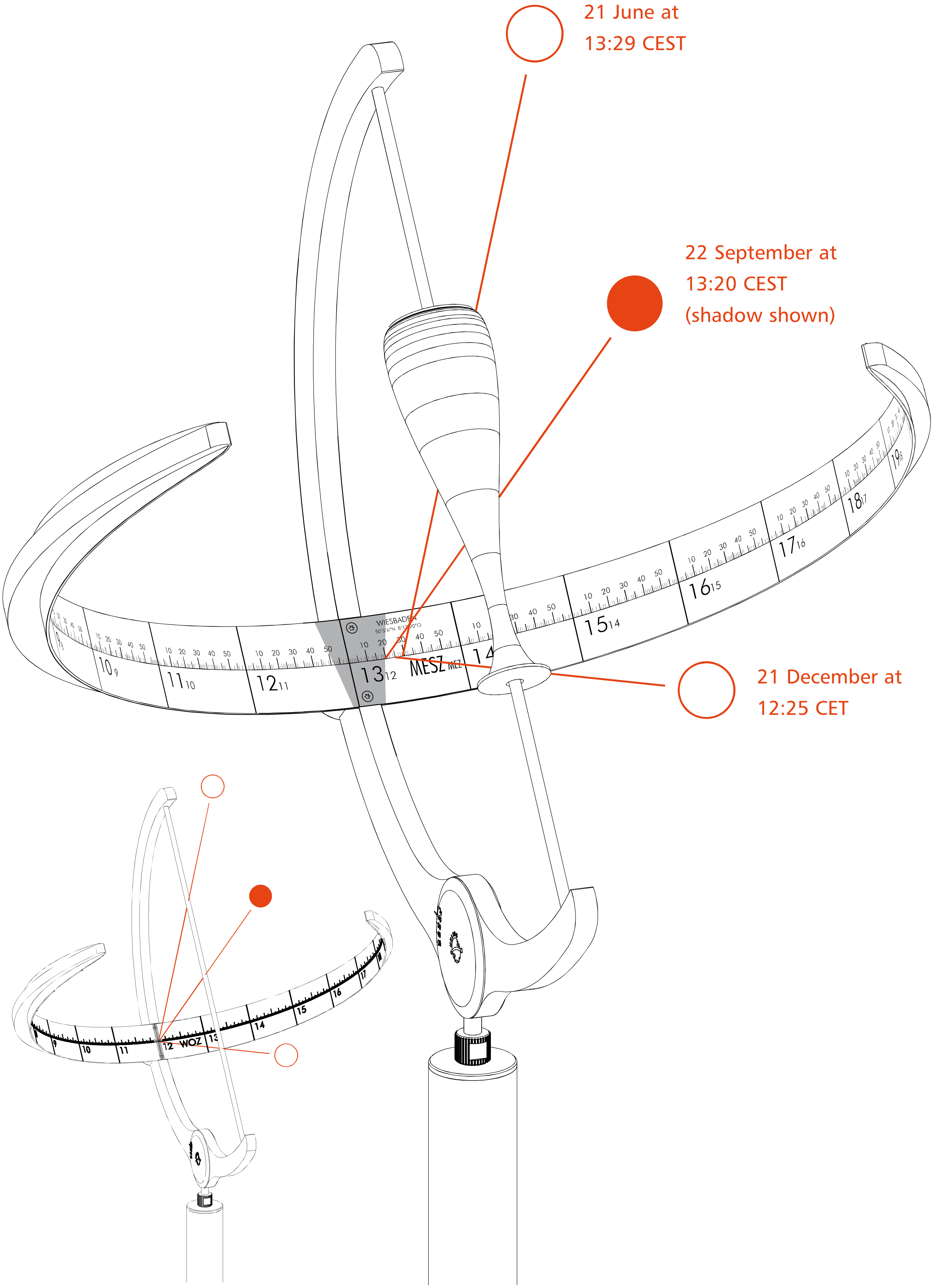


Fig. 1: Comparison of the CHRONOS LAT and the CHRONOS CET/CEST at true solar noon

True and mean solar time

You can often hear the viewer of a sundial say: „It is wrong!“, because he is comparing sundial time with that of the wristwatch. In fact, this is unfair: the sundial's display of true solar time (officially known as local apparent time or LAT) is absolutely correct.

In contrast, the time on the wristwatch is an average time, invented by man, which refers to a certain longitude, the time zone meridian. This is called zone time or standard time, in Central Europe this is the Central European Time (CET/CEST).

Standard time is not so easy to display on a sundial. During the year, the sundial may be 17 minutes fast and 15 minutes slow compared to the average. There are two explanations for this phenomenon.

Firstly, the Earth moves on an elliptical path around the Sun and is faster when near the Sun than when at a distance. Secondly, the apparent Sun moves along the ecliptic which is at an angle of 23.44° to the celestial equator. Only that part of the Sun's path in the direction of the celestial equator is relevant for time measurement. This part is also constantly changing throughout the year.

The difference between true and mean time is called the equation of time. Fig. 2 shows how the equation of time changes during the year.

True solar time is thus not a uniform time and therefore unsuitable for time measurement with mechanical watches. For this reason, an average time, the local mean time (LMT), had already been introduced for larger cities during the eighteenth century. It assumes a fictive, uniformly moving Sun on the equator and covers all places at the same longitude.

As early as the 19th century, Major General John Ryder Oliver invented a sundial (British Patent No. 1660 of 1892), which indicates the local mean time.

With the help of a rotationally symmetrical body, the shadow is shifted by the difference of the equation of time as a function of the seasons. In 1966, the German sundial designer Martin Bernhardt further improved this principle with the Bernhardt's roller, named after him.

The CHRONOS precision sundial CET/CEST is also equipped with time-equalizing rollers. You always need two rollers, one for winter/spring (ascending Sun) and the other for summer/autumn (descending Sun). Fig. 1 shows how the summer/autumn roller is used. In these two seasons, the Sun descends from the summer solstice on 21 June to the winter solstice on 21 December. If you observe the shadow of the roller, it moves upwards gradually every day. Since the outer shape of the roller corresponds to the equation of time curve, the time display is shifted by the equation of time value corresponding to the Sun's position. On the time scale, Central European Time (CET/CEST) or any other standard time can always be read off at the intersection of the leading shadow (right) with the circumferential center line (equator line).

Fig. 1 shows the CHRONOS LAT in the background, displaying 12:00 LAT always at true solar noon. At the same time, on the CHRONOS CET/CEST you can read different times for the CEST or the CET on three different days.

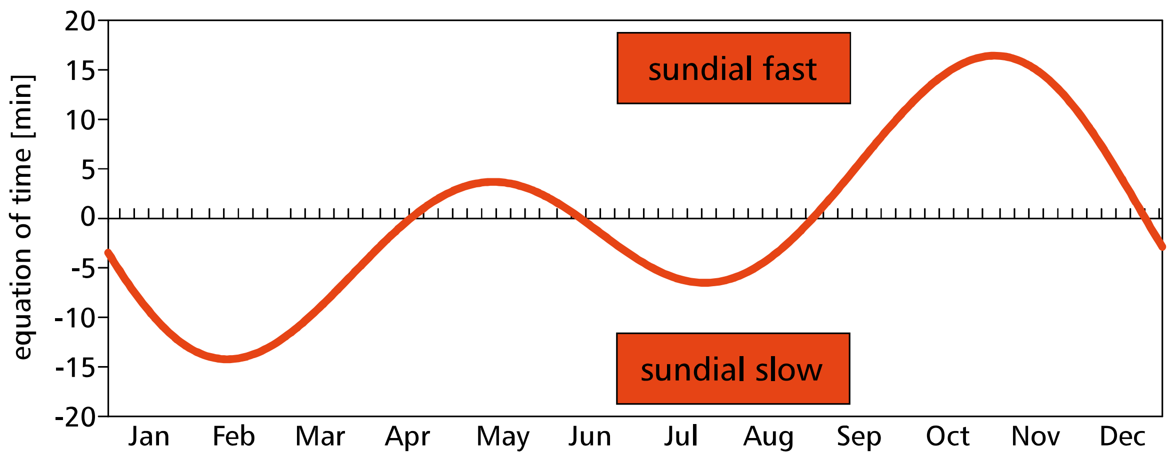


Fig. 2: The equation of time

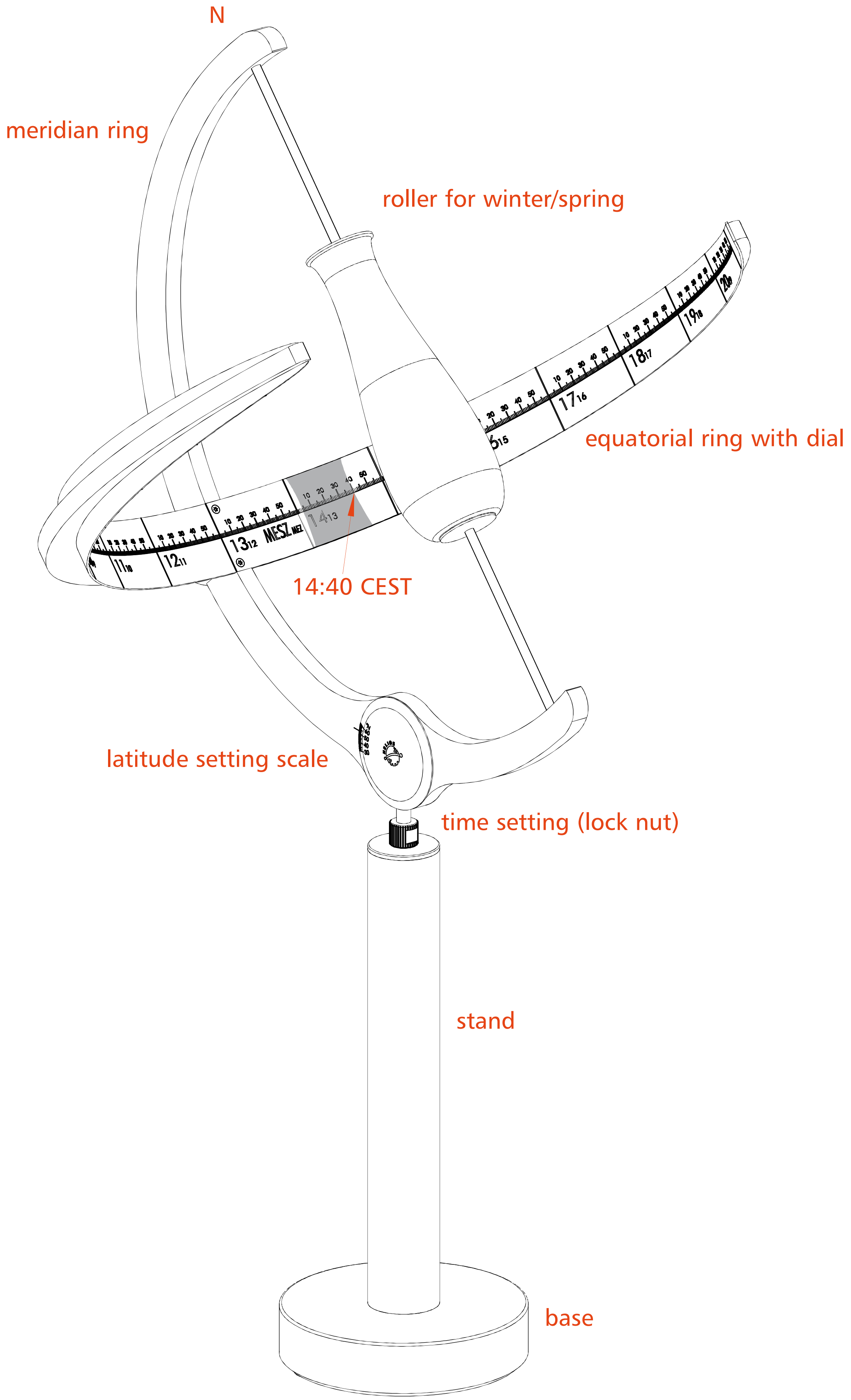


Fig. 3: The CHRONOS precision sundial with roller for winter/spring

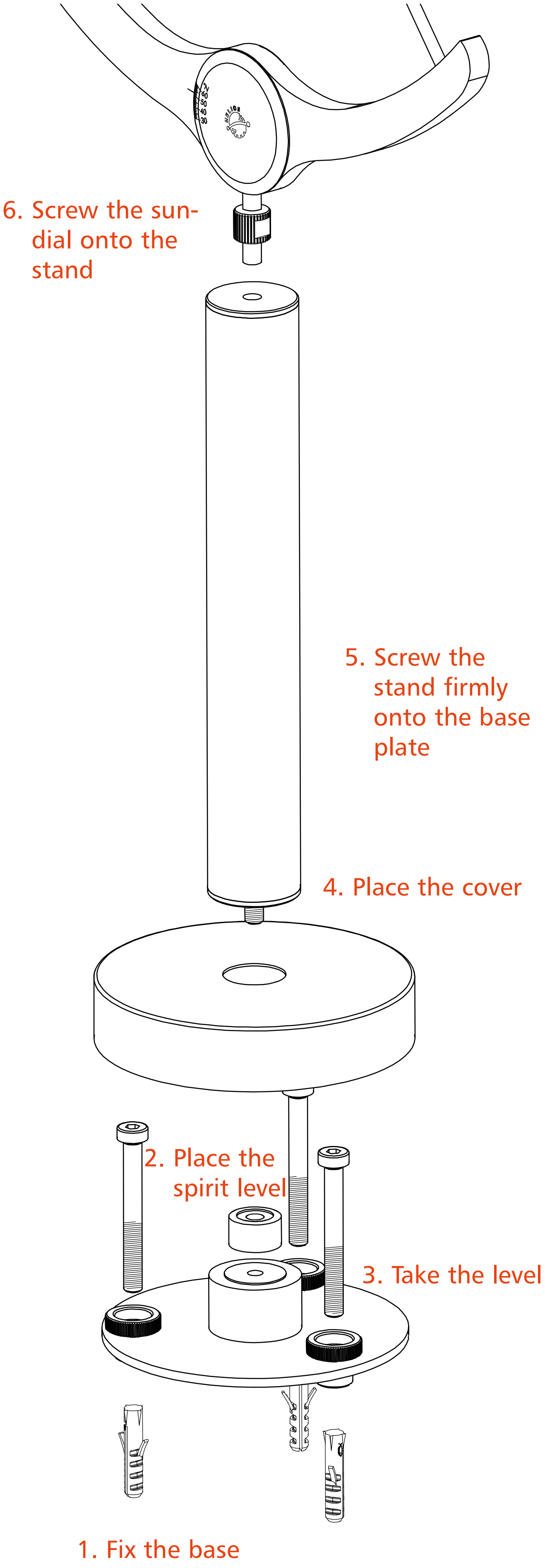


Fig. 4: Mounting the stand

Mounting the sundial

Choose a sunny place for your sundial CHRONOS. For mounting with dowels, you need a solid foundation of stone or concrete. A frost-proof foundation of approx. 200 mm diameter needs to be installed in the ground.

Careful assembly and alignment is important for the accuracy of the sundial. Proceed as follows (Fig. 4):

1. Place the base plate on the foundation. Mark the center of the holes in the knurled screws. Use an 8 mm drill to bore of deep holes at least 60 mm for the dowels and secure the base plate with the M6 screws.
2. Place the spirit level supplied in the middle of the base plate.
3. Align the base plate with the three leveling screws (air bubble of the spirit level within the black ring). Now tighten the screws.
4. Place the cover over the base plate.
5. Screw the stand firmly onto the base plate.
6. Screw the sundial onto the stand and tighten the locknut.
7. Loosen the rear knurled screw (not visible in the illustration) at the latitude scale and adjust the sundial's latitude (see table 2 on page 8) at the marking (Fig. 5). Tighten the rear knurled screw with the spanner supplied.

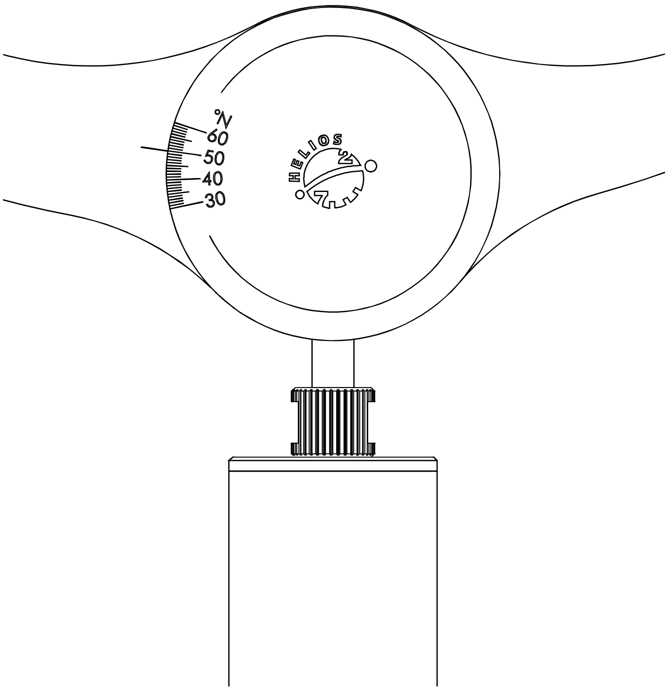


Fig. 5: Setting the latitude

Setting the time

If you have a compass on hand, you can orient the gnomon of the sundial to geographic north. With the help of the Sun and time comparison with an accurate clock, you can align the sundial even more precisely.

The time displayed by the CHRONOS precision sundial CET/CEST can be directly compared with the time on your watch. If, however, you want to align the CHRONOS precision sundial LAT with the watch, you first need to calculate Central European Time from the true solar time displayed.

Aligning the CHRONOS LAT

The time you can read in the center of the shadow is the true solar time, officially called local apparent time (LAT). For example, the sundial in Fig. 6 shows 13:30 LAT (1:30 p.m.) in Wiesbaden.

For example, to determine Central European Time (CET) from the time read off the sundial, three values are added:

1. Local time difference: Constant time difference to the CET time zone meridian, which is 15° east of Greenwich. The local time difference depends on the longitude of the site and can be taken from table 2 on page 8 for different cities. Example: The local time difference for Wiesbaden is 27 min.

2. Date-dependent time difference: This is the negative value of the equation of time. Example: On 25 April, the date-dependent time difference is -2 min.

3. Summer time (daylight saving time) difference: Summer time (CEST) is valid from the end of March to the end of October. An hour is added. This also applies in the example on 25 April.

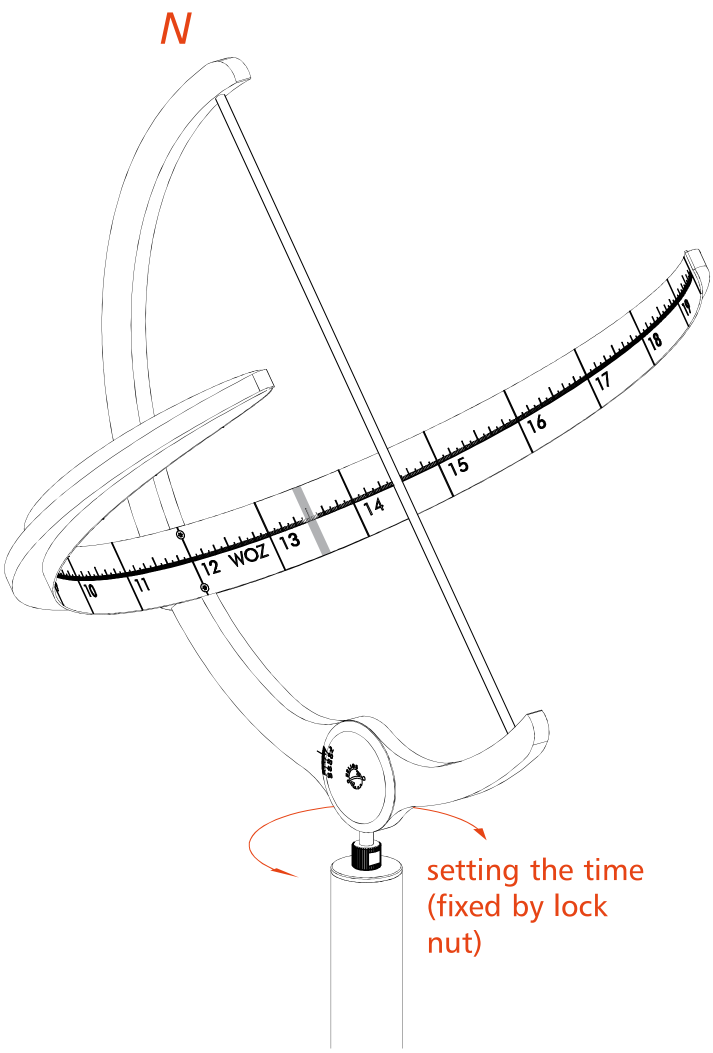


Fig. 6: The CHRONOS precision sundial displays 13:30 LAT.

The difference is summed as follows: 27 min - 2 min + 1 h = 1 h 25 min. So on 25 April at 13:30 LAT in Wiesbaden, it is already 14:55 CEST. If the calculated time does not match the watch, the sundial is not yet properly aligned. Loosen the locknut and turn the sundial until the calculated time coincides and reconnect the locknut with the spanner included. When the time is set, the sundial is aligned exactly to the north.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3	14	12	4	-3	-2	4	6	0	-10	-16	-11
5	5	14	12	3	-3	-2	5	6	-1	-12	-16	-9
10	7	14	10	1	-4	-1	5	5	-3	-13	-16	-7
15	9	14	9	0	-4	0	6	5	-5	-14	-15	-5
20	11	14	8	-1	-4	1	6	3	-6	-15	-14	-3
25	12	13	6	-2	-3	3	7	2	-8	-16	-13	0
30	13		5	-3	-3	4	6	1	-10	-16	-11	2

Table 1: Date-dependent time difference (minutes). This is the negative value of the equation of time.

Aligning the CHRONOS CET/CEST

If you have a CHRONOS precision sundial CET/CEST, you can compare the time read by the sundial directly with the time on your watch.

In this case, the tables are not required. The local time difference is taken into account in the time scale and the date-dependent time difference (negative value of the equation of time) is compensated by the rollers.

To align, proceed as follows: Set the roller according to the season. The rollers are marked on the upper side. In winter and spring from 21/22 December to 20/21 June use the "thick" roller. In summer and autumn from the 20/21 June to the 21/22 December the "thin" roller (Fig. 7).

For assembly, the roller with the spring is inserted into the top bore of the meridian ring and the other end is inserted into the lower bore. Press the roller upwards against the spring resistance.

The Sun now throws a shadow of the roller on the dial. The time is always read at the intersection of the leading shadow edge (right) with the circumferential center line (equatorial line) (Fig. 8). If the time read does not match the watch, the sundial is not properly aligned. Loosen the lock nut for the time setting (Fig. 6) and turn the sundial until the time displayed coincides with the watch. Finally, reconnect the locknut with the spanner supplied.

Tip: If the alignment is made around the time of the solstices, the accuracy is limited due to the calculation system applied. In this case,repeat the alignment again a few days after the respective solstice to obtain an accurate reading.

After the alignment has been completed, you can always read Central European time (small digits) or its summer time (daylight saving time) variant (large digits) from the CHRONOS precision sundial CET/CEST. If you have separate dials for CET and CEST, you will need to exchange them for the summer time changeover by loosening the four screws.

If you have any questions concerning the setting up of the sundial, please do not hesitate to call us: +49 (0) 611 - 185 11 06 or write an e-mail to email@helios-sundials.com

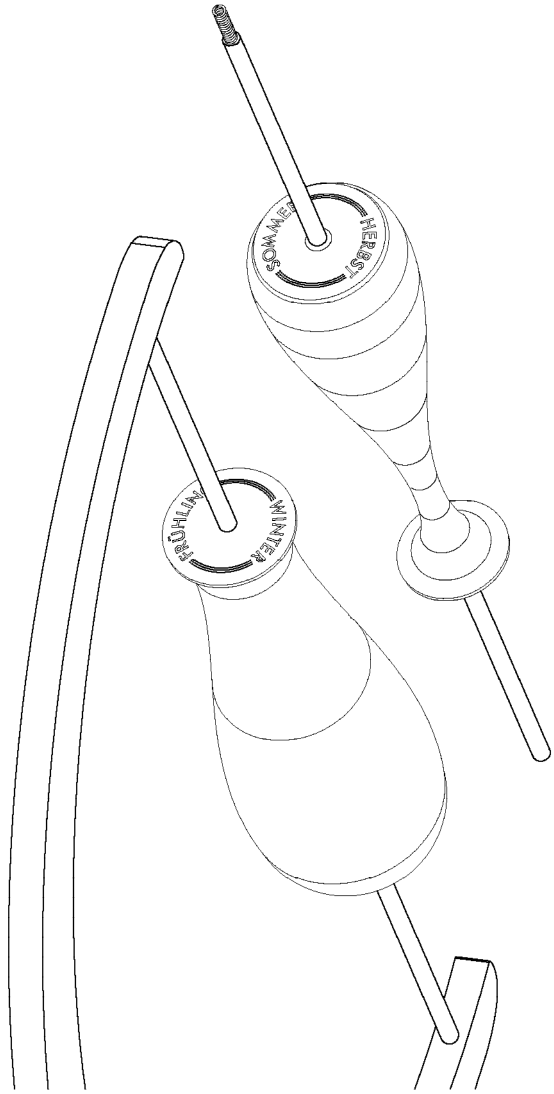


Fig 7: The rollers are used according to the season.

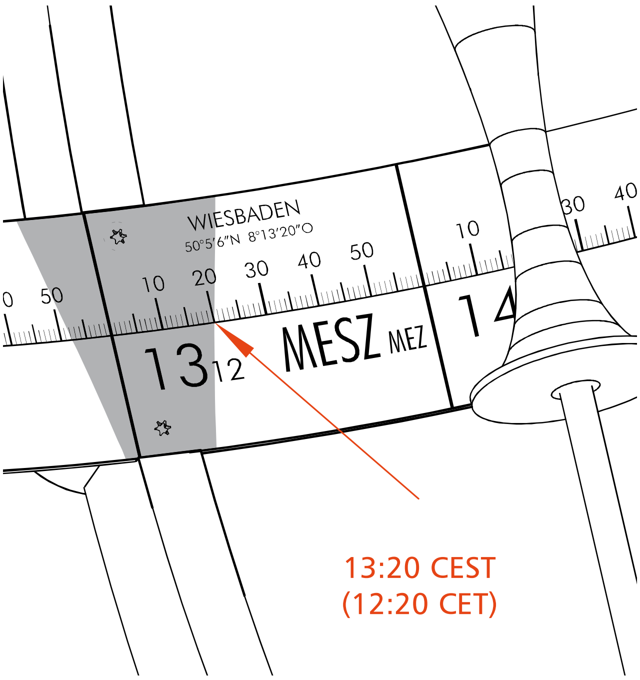


Fig 8: The time is always read at the right shadow edge. Here it is 13:20 CEST.

City	Lat. °N	Lon. °E	T. dif. [min]	City	Lat. °N	Lon. °E	T. dif. [min]
Aachen	50,8	6,1	36	Jena	50,9	11,6	14
Augsburg	48,4	10,9	16	Kaiserslautern	49,4	7,8	29
Aurich	53,5	7,5	30	Karlsruhe	49,0	8,4	26
Baden-Baden	48,8	8,2	27	Kassel	51,3	9,5	22
Bamberg	49,9	10,9	16	Kiel	54,3	10,1	20
Basel	47,5	7,6	30	Köln	50,9	7,0	32
Bautzen	51,2	14,4	2	Konstanz	47,7	9,2	23
Bayreuth	50,0	11,6	14	Klagenfurt	46,6	14,3	3
Berlin	52,5	13,4	6	Leipzig	51,3	12,4	10
Bern	47,0	7,4	30	Linz	48,3	14,3	3
Bielefeld	52,0	8,5	26	Lübeck	53,9	10,7	17
Bonn	50,7	7,1	32	Magdeburg	52,1	11,6	14
Braunschweig	52,3	10,5	18	Mainz	50,0	8,3	27
Bremen	53,1	8,8	25	Mannheim	49,5	8,5	26
Celle	52,6	10,1	20	München	48,1	11,6	14
Chemnitz	50,8	12,9	8	Münster i. W.	52,0	7,6	30
Coburg	50,3	11,0	16	Neubrandenburg	53,6	13,3	7
Cottbus	51,8	14,3	3	Nordhausen	51,5	10,8	17
Darmstadt	49,9	8,7	25	Nürnberg	49,5	11,1	16
Dessau	51,8	12,2	11	Osnabrück	52,3	8,0	28
Dortmund	51,5	7,5	30	Passau	48,6	13,5	6
Dresden	51,1	13,7	5	Plauen	50,5	12,1	12
Düsseldorf	51,2	6,8	33	Potsdam	52,4	13,1	8
Emden	53,4	7,2	31	Regensburg	49,0	12,1	12
Erfurt	51,0	11,0	16	Rostock	54,1	12,1	12
Essen	51,5	7,0	32	Saarbrücken	49,2	7,0	32
Flensburg	54,8	9,4	22	Salzburg	47,8	13,1	8
Frankfurt/M	50,1	8,7	25	Schwerin	53,6	11,4	14
Frankfurt/O	52,3	14,6	2	Speyer	49,3	8,4	26
Freiberg i. Sa.	50,9	13,3	7	Stralsund	54,3	13,1	8
Freiburg i. Br.	48,0	7,9	28	Stuttgart	48,8	9,2	23
Gera	50,9	12,1	12	Suhl	50,6	10,7	17
Gießen	50,6	8,7	25	Trier	49,8	6,6	34
Görlitz	51,2	15,0	0	Ulm	48,4	10,0	20
Göttingen	51,5	9,9	20	Weimar	51,0	11,3	15
Graz	47,1	15,5	-2	Wien	48,2	16,3	-5
Greifswald	54,1	13,4	6	Wiesbaden	50,1	8,2	27
Güstrow	53,8	12,2	11	Wismar	53,9	11,5	14
Halle/Saale	51,5	12,0	12	Würzburg	49,8	9,9	20
Hamburg	53,6	10,0	20	Zittau	50,9	14,8	1
Hannover	52,4	9,7	21	Zürich	47,4	8,6	26
Innsbruck	47,3	11,3	15	Zwickau	50,7	12,5	10

Table 2: Geografic coordinates and local time difference of European cities.
Formula: Local time difference (time dif.) = (15° - eastern longitude) x 4 min/°