# Multiple solar transits to measure the deviation of the meridian line in Palazzo Mattei di Giove in Rome (1780)

Costantino Sigismondi *prof.sigismondi@icra.it*
*(ICRANet Pescara; Istituto Scienza e Fede-UPRA Roma)*
Nicoletta Lanciano *nicoletta.lanciano@uniroma1.it*
*(Sapienza University of Rome)*
Angelo Bruno *ramanuyan50@gmail.com*
*(Ministero della Difesa)*
Claudio Costa *ccosta@specola.va*
*(Specola Vaticana)*

Submitted Nov 8th 2024, revised and accepted Nov 27th 2024

**Abstract** The (pinhole) meridian line located in the Mattei di Giove palace in Rome was built by André Febres (1734-1790) in 1780. On 7 Nov 2024 we measured its Eastward 12' deviation from North exploiting 4 pinhole images created with 4 temporary pinholes disposed on a vertical line.

**Sommario** La meridiana a foro stenopeico creata dal Gesuita André Febres (1734-1790) nel 1780, in una stanza del Palazzo Mattei di Giove, dove oggi è la Direzione della Biblioteca di Storia Moderna e Contemporanea, è stata calibrata il 7 novembre 2024. Abbiamo usato 4 fori stenopeici disposti in linea verticale, e abbiamo cronometrato i 4 transiti delle immagini sul pavimento dove è tracciata la linea meridiana e molte altre linee ancillari. Le differenze tra i vari transiti sono state ricondotte alla deviazione della linea meridiana tramite i calcoli sulla velocità angolare del Sole, proiettata nei 4 punti d'intersezione con la linea meridiana, con i rispettivi raggi (foro-immagine). La deviazione ottenuta pari a 12'±1' servirà a capire quale sia stato il tempo di riferimento considerato per il transito meridiano con cui Febrès ha stabilito la direzione della linea, poi scolpita sul pavimento.

**Keywords:** Meridian Line, Pinhole, Azimuth, Sun Transit, André Febres.

**Introduction:** the Jesuit André Febres realized in the summer of 1780 a pinhole meridian line for the duke Mattei in a room on the last floor of the building. He described in details all the functions of this instrument (Febres, 1780) used as sundial. Febres represented also 14 stars, as in the great meridian line of S. Maria degli Angeli, to which he was indeed inspired. The aim of this paper is to measure the deviation from the celestial North of this small meridian line, which is 1:21 with respect to S. Maria degli Angeli's one. This deviation includes art, science and technical issues in Rome at the end of '700.

Other papers will be dedicated to the presentation of this historical instrument, to its functional restoration and to the relevance for the history of the Jesuits (suppressed by Clement XIV in 1773 and until 1814) of this work, probably made in clandestine regime, by André Febres (Manresa 1734-Cagliari 1790). Here we mention that the meridian line is 1685 mm long from Cancer to Capricorn solstices, and the original pinhole, lost, was 914 mm high, not specified in the author's text, if horizontally (as in S. Maria degli Angeli) or vertically oriented.

**The quadruple solar transit of 7 Nov 2024**

We used four vertically oriented pinholes, at different heights in order to sample four different parts of the meridian line. If the line is exactly directed toward North and the pinholes are on the vertical of its zero point, the transits occur at the same time of the local ephemerides, otherwise each image crosses differently the line. The angular velocity of the Sun in the sky is approximately $\omega=15''/s\ \cos(\delta)\approx 7.3\cdot 10^{-5}\cos(\delta)$ rad/s, the distance from the pinhole at height h and the ground, along the solar line of sight is $d=h\sqrt{(1+\tan^2 z)}$ with the zenital angle $z\approx\lambda+\delta$, with the latitude or Rome $\lambda\approx 41.9°$ and $\delta$ is the declination of the Sun at during the observation $\delta\approx -16.5°$. The solar images on the ground move at velocities $v_i=\omega\cdot d_i$.

For the explanation, and for practical issues on such small meridian line, here the numbers have be rounded to the first decimal, but in the calculations we used all digits.

| Pinhole | h mm | Vel.mm/s | W_dev | O-C [s] | Dev mm |
|---|---|---|---|---|---|
| CNC | 168.5 | $2.23\cdot 10^{-2}$ | 13 | -279.1 | -5.6 |
| EQUI | 498.5 | $6.6\cdot 10^{-2}$ | 11,5 | -70.3 | -1.8 |
| SCO | 808.5 | $10.7\cdot 10^{-2}$ | 10,5 | -17.1 | -4.6 |
| CAP | 1054.5 | $13.9\cdot 10^{-2}$ | 10,5 | -6.7 | -0.9 |

Table 1: Pinholes caracteristics and transit timings

The timings are compared with the ephemerides of the pinholes for their measured West deviation from the vertical.

The CNC=Cancer pinhole was 13 mm W from the vertical, the velocity of its image was $v=2.23 \cdot 10^{-2}$ mm/s, so its transit, if the meridian line was Northward, should occur 583 s after the local transit, at 11:53:46, but it was observed 334 s after, with an advance of 279 s (tabulated in the 4th column). The same operations were done for the other pinholes, obtaining finally the deviations from the ideal meridian line, starting from the zero point of the real line.

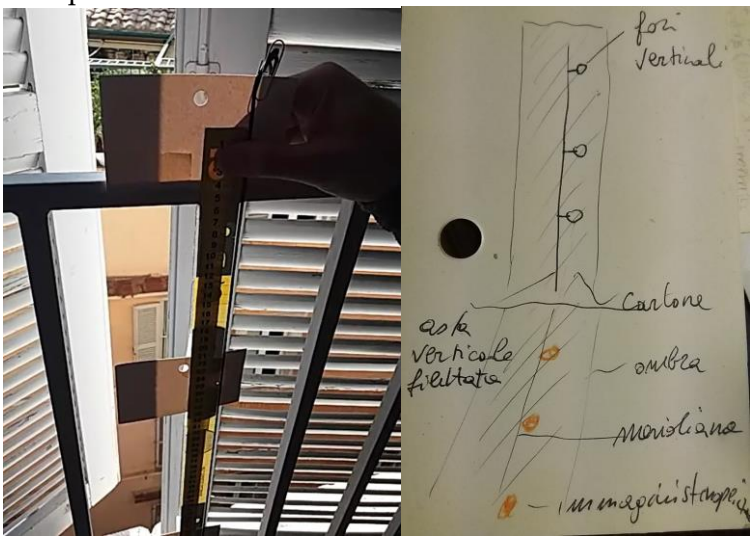



Fig. 1-2 the real pinholes and their project.

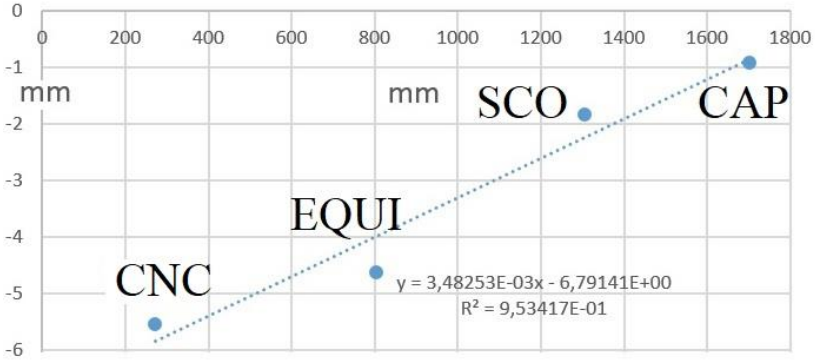



Fig. 3 The real line with respect to a N-S orientation (- is West)



Fig. 4 the four transits as recorded with the cameras. Top CAP and SCO, bottom EQUI and CNC.

**Conclusions** The line is deviated 12'±1' Eastward from North. Being traced in Summer the noon signal's error propagated to this extent. Especially in the CNC image with ♋ we see that the thickness of the line is comparable with ¼ of the solar diameter, or about 35 s in time, and the penumbra effect (the diameter of the pinhole) is percentually relevant with such small instrument. **Ref.**A.Febres,*Spiegazione*[…](1780) (archives)