Science with an historical instrument: the Clementine Gnomon in St. Maria degli Angeli in Rome

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Abstract The Clementine Gnomon, also known as the Meridiana of Santa Maria degli Angeli in Rome, is a scientific monument. It is still contributing to the knowledge of the Sun through dedicated observations, which can be compared with the ones made in the 18th century. A short review on some recent publications is presented for the touring scientist or amateur.
Sommario La Meridiana Clementina a Roma è un monumento scientifico, ancora in funzione. Le osservazione condottevi consentono –comparandole con quelle del 18° secolo– di verificare variazioni nel Sole. Una rivista delle più recenti pubblicazioni è presentata a vantaggio del turista scientifico.

Introduction Is it possible that an historical instrument, built in 1701 upon the will of the Pope Clemens XI (1700-1721), and payed by him when he was still Cardinal, is still working and producing data useful for Science?

The astronomer who projected it was Monsignor Francesco Bianchini (Verona 1662- Roma 1729), he was also historian and archeologist; Rome was really his Laboratory.[1]

He was member of the French Academy of Science and of the Royal Society of London, renowned in all Europe for his studies. (J. L. Heilbron, 2022)[2]

[1] E. Maglaque, Rome Was His Laboratory, The New York Review, 6 october 2022 https://www.nybooks.com/articles/2022/10/06/rome-was-his-laboratory-francesco-bianchini/

[2] The Incomparable Monsignor: Francesco Bianchini's World of Science, History, and Court Intrigue. Oxford University Press. (2022)

The Clementine Gnonom (F. Bianchini, 1703),[3] better known as the Meridian Line of Santa Maria degli Angeli in Rome, is a giant pinhole-illuminated meridian line, 45 meters long with the illuminating circular horizontal pinhole of 25 mm located at 20.35 m of height. The zodiacal signs realized by Francesco Tedeschi with marble inlays are truly masterpieces (fig. 1).



Fig. 1 The Aquarius with the first magnitude star Fomahant at its bottom, according to Johannes Bayer's Uranometria (1603) [4]

[3] De Nummo et Gnomone Clementino, auctore Francisco Blanchino Veronensi, Romae 1703.

[4] C. Sigismondi, Fomahant Aquarii, Cor Scorpii Antares e il principe Federico Cristiano di Sassonia a S. Maria degli Angeli, Balmer 3, 1

The daily Meridian Transit

Each day of the year the Sun projects its image on the floor of the Basilica and on the yellow and white marbles around the Meridian Line, with the hypotenuse of a right triangle drawn ideally by its rays.
An ellipse is formed on the floor; the one in fig. 2 is 38 cm long, and it ranges from 22 cm (June's solstice) to 110 cm (December's solstice).



Figure 2: The image of the Sun on 28 September 2025 at 12:58:55. Its position corresponds to the Northern star of the Libra, and the solar zenithal distance is 44°, so the altitude is 46° above the horizon. This image moved at 2 mm/s toward the left, covering itself in 2 minutes 20 seconds.

(2025) https://www.icra.it/BALMER/2025/Balm-3-2025-Sigismondi-Fomahant-1-10.pdf

The instant of the meridian transit divides the day in two equal parts,[5] and it was the moment of the Angelus' prayer. Nowadays the noon time is the same for all Central Europe.

The summer daylight savings moved the average noon of Rome at 13:10 PM from the end of March to the end of October. With the Church closing every day from 13 PM to 16 PM there is a problem for assisting to the meridian transit.
Another problem occurs in the months from November to March, when the sunlight casts the solar image in front of the Presbytery: the area is accessible only for prayer. Therefore the visit of the Meridian Line with the Sun on it has to be agreed with the parish's office.[6]

After these premises, I can answer to the starting question: the Meridian Line is still worth of Scientific Studies.

Measuring the Sun along the centuries

Recently 1300 azimuthal diameters of the solar image taken from December 2024 to June 2025 have been used to study if the secular variations of the solar diameter could have been measured with this Meridian Line[7] and with the one of San Petronio in Bologna.

[5] https://youtu.be/xRIk_IPgvZ8 C. Sigismondi, video of the solar transit of 28 September 2025.
[6] https://www.santamariadegliangeliroma.com/contatti/
[7] C. Sigismondi, A. Brucato and G. Andreasi Bassi, Solar Astrometry in Rome at the End of the Maunder Minimum, Universe 11, 186 (2025)

The Meridian Line of Santa Maria degli Angeli in Rome contributed to build the modern idea of our Sun.[8]

The Stars and the Earth's revolution

In 25 years of observations at this Meridian Line I could perform very detailed astrometric measures, finding evidences of first order relativistic effects observed –without recognizing them – already by Francesco Bianchini in the first quarter of the 18th century.

These effects are buried under the results that he published in his book and in carved on a marble slab located in the presbytery (Fig. 3). They appear as a tiny differences between the ephemerides calculated nowadays for the seasons' dates and the observations made by him. Until the first quarter of 21st century these differences were attributed to normal observational errorbars, but now we know that Bianchini observed correctly and carefully everything, and the stars used for his measures were moving around their average yearly position because of the Stellar Aberration due to Earth's revolution. (Sigismondi 2008,[9] 2021[10] and 2023 [11])

[8] C. Sigismondi, Modern view of the Sun: materials for an experimental history before the telescope, Histories 5 (4), 48 (2025)
[9] C. Sigismondi, Stellar and Solar Positions in 1701-1703 Observed by Francesco Bianchini at the Clementine Meridian Line in the Basilica of Santa Maria degli Angeli in Rome, and its Calibration Curve, Proc. XI Marcel Grossmann Meeting, 2470 World Scientific (2008)
[10] C. Sigismondi, Earth's Obliquity and Stellar Aberration Detected at the Clementine Gnomon (Rome, 1703), Phys. Sci. Forum 2021, 2(1), 49; https://doi.org/10.3390/ECU2021-09323



Fig. 3 the marble table with the equinoxes and solstices of 1703,[11] in the presbytery.

The boreal gnomon and the ellipses of the Polaris

A final note is about the ellipses of the Polaris that are near the base of the pinhole. They are concentric and the larger one is 5 meters wide; they represent the orbits of the Polaris during the Jubilee years.

A permanent exhibit named "Stellae Laetatae Sunt"[12] explains in the Basilica this unique monument to the Jubilees from 1700 to 2500 AD, in which religion and science are fused together (fig. 4).

[11] C. Sigismondi and S. Pietroni, Solstices and Equinoxes in 1703 at the meridian line of St. Maria degli Angeli in Rome, and the stellar aberration of Sirius. Proc. XVI Marcel Grossmann Meeting, 2388 World Scientific (2023)

[12] https://www.icranet.org/index.php?option=com_content&task=view&id=1573

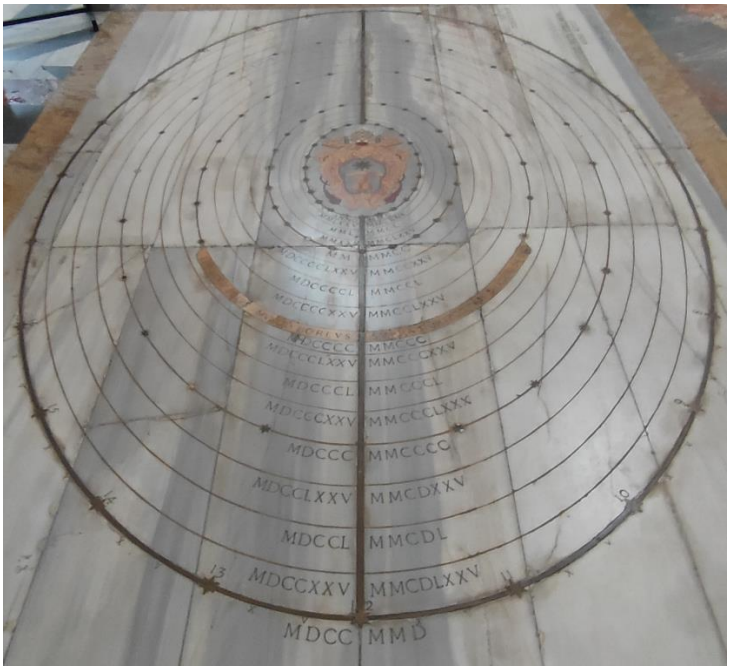


Fig. 4 the Starred ellipses of the secular Jubilees from 1700 to 2500 AD in the Basilica of St. Maria degli Angeli e dei Martiri in Rome.

References

J. L. Heilbron, The Sun in the Church: Cathedrals as Solar Observatories, Harvard University Press. (2001)

J. L. Heilbron, The Incomparable Monsignor: Francesco Bianchini's World of Science, History, and Court Intrigue. Oxford University Press. (2022)

E. Maglaque https://www.nybooks.com/articles/2022/10/06/rome-was-his-laboratory-francesco-bianchini/ (2022)

F. Bianchini, De nummo et gnomone Clementino, Romae 1703. https://archive.org/details/bub_gb_IYtGjIE_X64C

C. Sigismondi, A. Brucato and G. Andreasi Bassi, Solar Astrometry in Rome at the End of the Maunder Minimum, Universe 11, 186 (2025) https://www.mdpi.com/2218-1997/11/6/186

C. Sigismondi, Stellar and Solar Positions in 1701-1703 Observed by Francesco Bianchini at the Clementine Meridian Line in the Basilica of Santa Maria degli Angeli in Rome, and its Calibration Curve, Proc. XI Marcel Grossmann Meeting, 2470 World Scientific (2008)

C. Sigismondi, Earth's Obliquity and Stellar Aberration Detected at the Clementine Gnomon (Rome, 1703), Phys. Sci. Forum 2021, 2(1), 49; https://doi.org/10.3390/ECU2021-09323

C. Sigismondi and S. Pietroni, Solstices and Equinoxes in 1703 at the meridian line of St. Maria degli Angeli in Rome, and the stellar aberration of Sirius. Proc. XVI Marcel Grossmann Meeting, 2388 World Scientific (2023)

C. Sigismondi, video of the solar transit of 28 September 2025. https://youtu.be/xRIk_IPgvZ8 (2025) C. Sigismondi, Fomahant Aquarii, Cor Scorpii Antares e il principe Federico Cristiano di Sassonia a S. Maria degli Angeli, Balmer 3, 1 (2025)

C. Sigismondi, Modern view of the Sun: materials for an experimental history before the telescope, Histories 5 (4), 48 (2025) https://www.mdpi.com/2409-9252/5/4/48