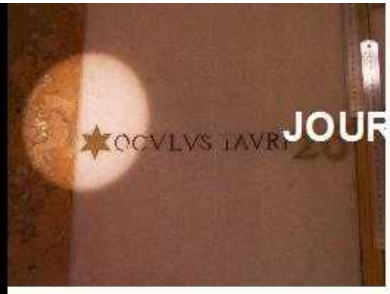

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Measuring Earth's Obliquity in 1701 at the Clementine meridian line in Rome

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Measures of the Earth Obliquity during 1701 winter solstice at the Clementine meridian line in Rome

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Session 3 (poster)

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The great meridian line in the Basilica of Santa Maria degli Angeli in Rome was built in 1701/1702 with the scope to measure the Obliquity of the Earth's orbit in the following eight centuries, upon the will of pope Clement XI. During the winter solstice of 1701 the first measurements of the obliquity have been realized by Francesco Bianchini, the astronomer who designed the meridian line, upgrading the similar instrument realized by Giandomenico Cassini in San Petronio, Bononia. The accuracy of the data observed by Francesco Bianchini is discussed and compared with up-to-date ephemerides. The modern situation of this historical instrument is also presented.

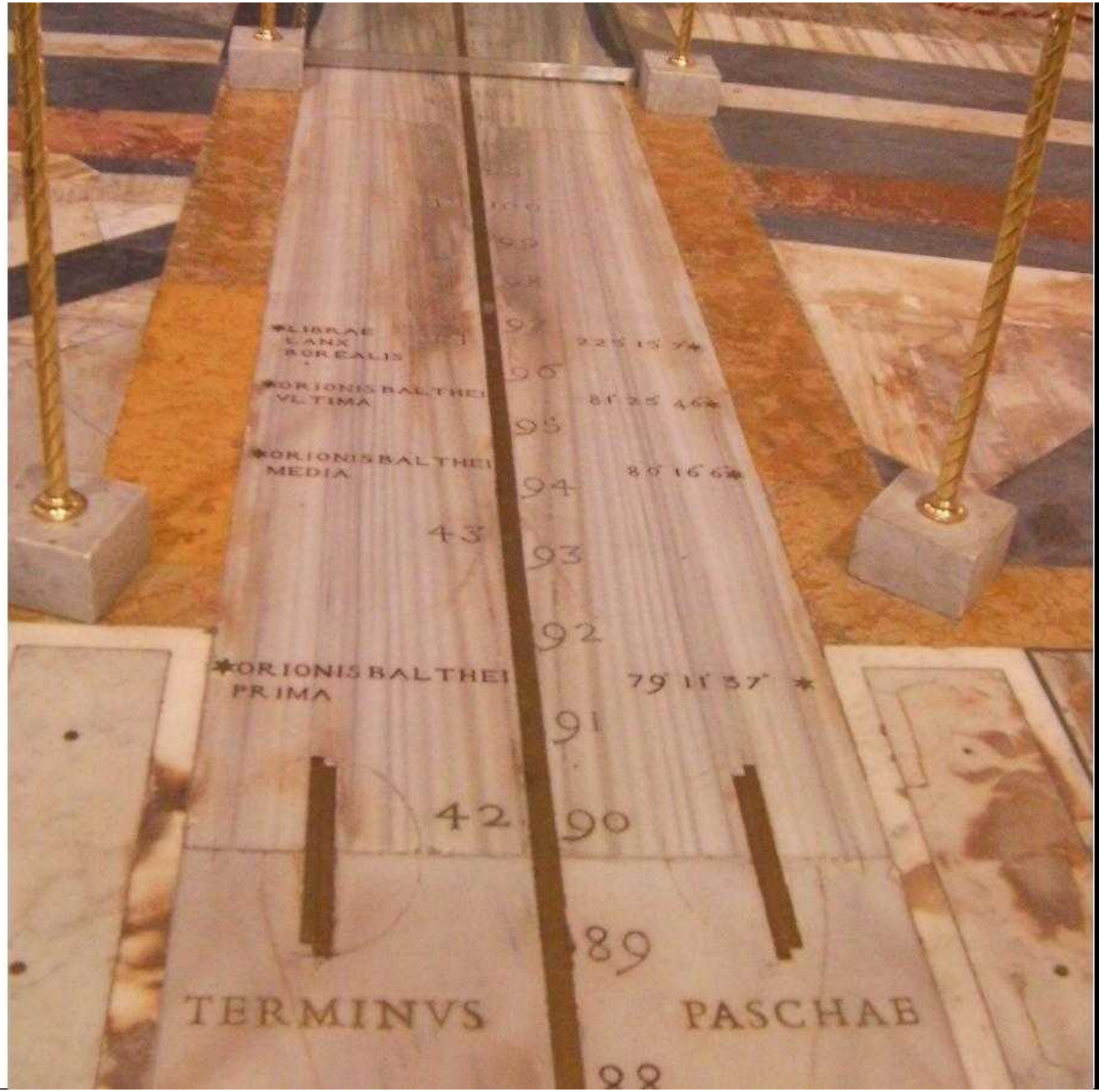
The Meridian Line built in 1701 in the basilica of S. Maria degli Angeli in Roma by the astronomer F. Bianchini 1662-1729

On the left-hand side the zenith distance (z=43°, 42°...) in degrees

On the right side of the line c=100*tan(z) e.g. 93~100*tan(43°)

Near 42 is the projection of the Celestial Equator (for latitude 41°54')

And the Terminus Paschae, i.e. The lowest Easter date: 22 march according to Nicea Council (325 a.C.)



The image of the Sun is projected through a pinhole on the floor moving up on Sept 2nd 2014 The center of the Sun has c~67.6 in perfect agreement with IMCCE ephemerides for the day of z=34.0548 or c=67.590. Bianchini could measure the nearest arcsecond by drawing both the locations of the Southern and the Northern limbs of the Sun.

The Clementine (built by will of Pope Clement XI) Meridian Line at the position of the Winter Solstice (beginning of Capricorn sign)

The center of the Sun is near c~217 , the Southern limb exceeds c~220
The Northern is around c~215

In 1701 due to the larger value of obliquity of the Ecliptic
e=23° 28.7'
the Southern limb entered the perimeter of the image of the zodiacal sign, while nowadays it does not.

Timing of 1703 equinoxes and solstices

Post Med Noct = PMN after local midnight
P MER = Post Meridiem

Detail of 1703 Winter solstice (Solstitium Brumalis) timing 11h 45m after local midnight i.e.10:54 UT of saturday 22 Dec. IMCCE ephemerides give the solstice timing at 11:10 UT

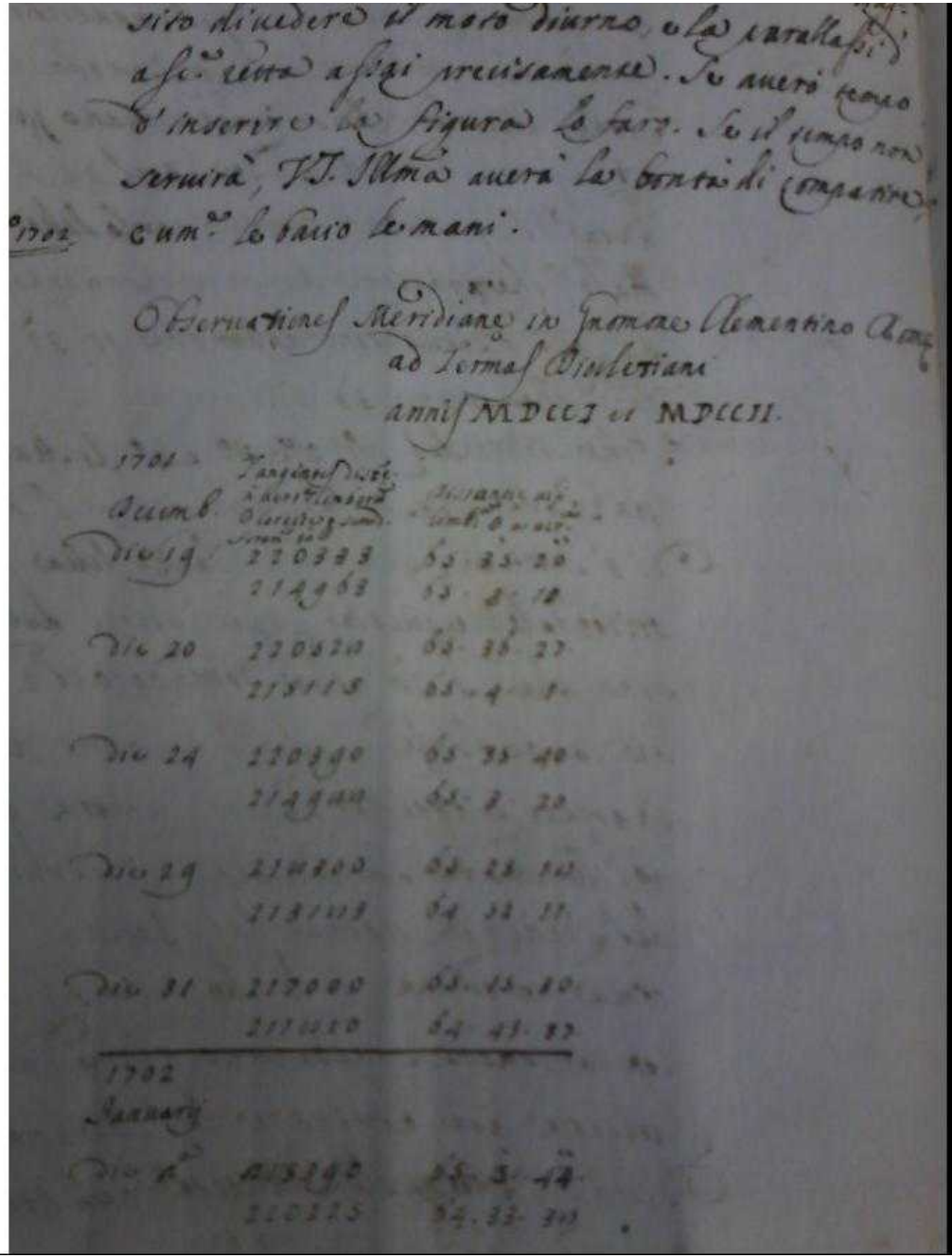
Manuscript of the letter prepared to the Pope Clement XI
containing the first results obtained at the Clementine Meridian Line

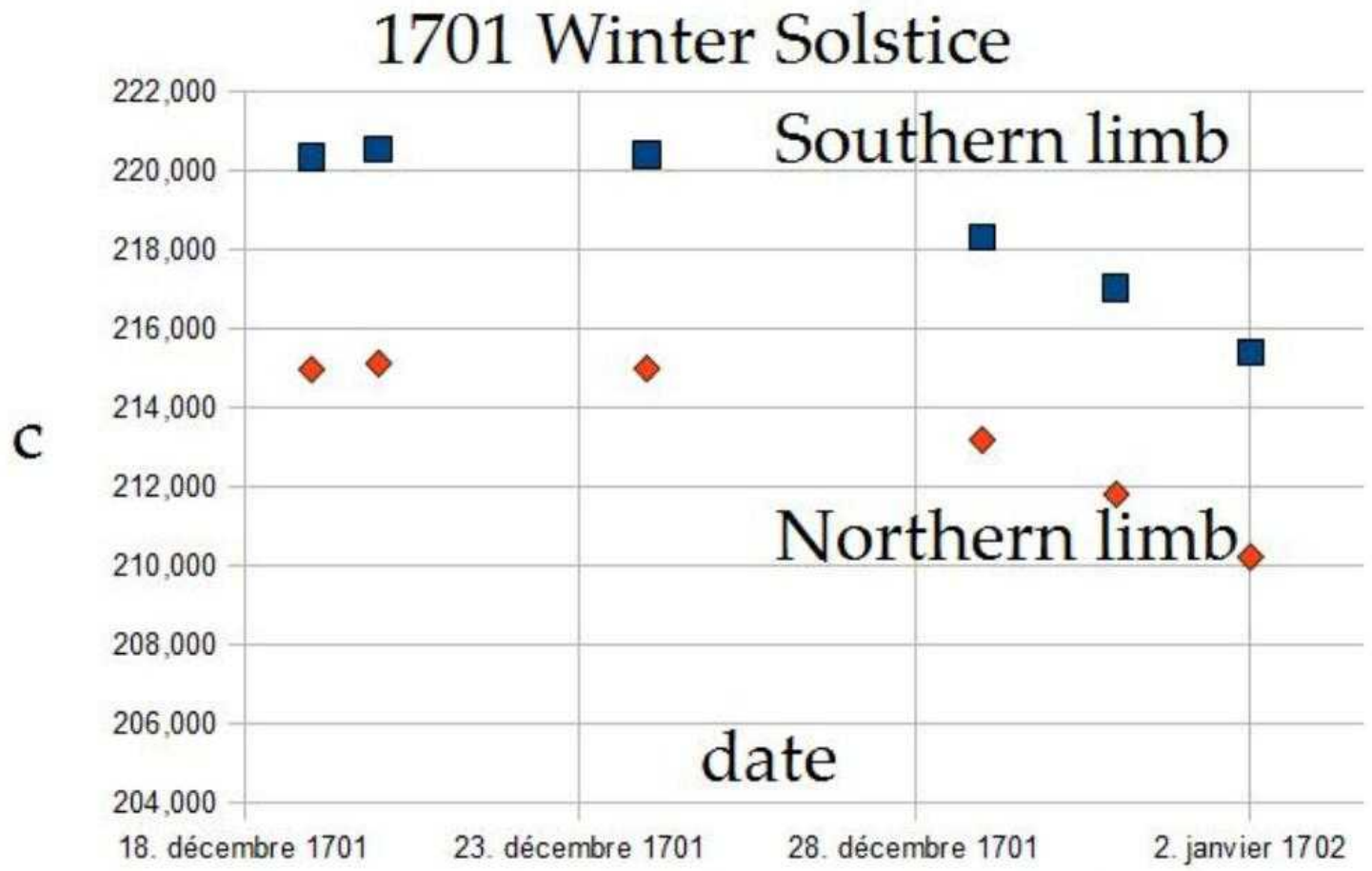
This page is preserved in the «Bianchini archive» at the Vallicelliana Library in Rome.

The values of c are measured up to the third decimal
c= 220.333 on December die 19 for Southern limb and
c= 214.963 for Northern one

There are 6 days of measurements 19, 20, 14, 29 and 31st december 1701 and 2nd January 1702.

These data are unpublished, unlike the ones of 1703, either graved on the marble slab and printed in the book « De Nummo et Gnomone Clementino » of 1703 (Romae).





Graphical representation of the data in the letter of Francesco Bianchini to Pope Clement XI.
The quadratical fit with Southern limb yields 22.17 December for the solstice
For Northern limb 21.94 Dec. Averaging we obtain a solstice time of 22.06 December 1701 at 01h 26m, i.e. 22 Dec 1701 at 00:26 UT.
IMCCE Ephemerides give 21 Dec 1701 at 23:35 UT with +51 minutes of difference (O-C).

The same quadratic fit yields for the extreme positions of the two limbs of the Sun, corresponding to the Solstice time

Southern 220.595

Northern 215.228

These are connected with the values z unperturbed by the atmosphere
z=z_obs-60"*tan(z_obs)
According to the Laplace's law (to the first order)

And the unperturbed center of the solstitial Sun is such that its declination is δ=-23°28'48"

being 41° 54' 11.2" the latitude of the pinhole

The true obliquity $|\delta|$ =The mean obliquity $\varepsilon+\Delta\varepsilon$
$\Delta\varepsilon$ is the nutation in obliquity and for 22 dec 1701
$\Delta\varepsilon$ = -6".3

Finally the observed mean Obliquity for that date
ε=23°28'54.3"

In excellent agreement with the calculations for the mean obliquity in 1702.0
ε=23°28'40.9" (J. Laskar) ε=23°28' 58.6" (P. Duffet-Smith 1st order)

For ε, despite first order approximations for atmospheric refraction, the O-C <14"

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