The urban set of the Pantheon and the Mausoleum of Augustus in Rome, between architectural and astronomical symbolism.

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Summary
Until 1995 it was thought that the Pantheon of Augustus had the entrance on the south side in contrast to that of the next scheduled time of Hadrian, that has placed it in the north. The archaeological excavation of the Sovrintendenza Capitolina di Roma, directed by P.Virgili, in the years 1995-97, have shown that the Pantheon of Augustus was exactly like what Hadrian has rebuilt later and that we see today.
Even the surveys conducted in the years 2007-2009 on the Mausoleum of Augustus, inside and on the forecourt, allowed to advance new hypotheses about the ground plan of the monument and its rearrangement made by a successor of Augustus.
In 1990 N.Lanciano published a reading of the Pantheon as a solar calendar that use the light entering from the oculus and scans the interior space, at solar noon, in the days of the Equinoxes and Solstices, in addition to the April 21 birthday of Rome.
All these searches shows the two buildings, Pantheon and Augustus's Mausoleum, more formal and symbolic links than was supposed. With attention to contemporary written sources, issues arise:
- Orientation of the axes of the buildings,
- Of their distance middle-deambulatio, takes about 15 minutes on foot, in relation to the direction of sunlight on their respective axes and portals,
- Organization of the squares on which thay open,
- Geometry of the inner dome and hall of the Pantheon.
In urban complex of Augustus is inserted also the monumental sundial mentioned by Pliny and partially excavated by Buchner in 1979, with the location and function of the Ara Pacis: recent research lead to exclude some hypotheses still present in articles and in the web. We present the modern reuse (1990) of the obelisk that served as a gnomon in the above horizontal sundial.

1. ARCHAEOLOGICAL INVESTIGATION OF THE PANTHEON PV

In 1995, Virgili has directed an archaeological investigation extended for more than 200 square meters, on the front of Hadrian's Pantheon, on behalf of the Sovritendenza ai Beni Culturali of the Municipality of Rome, among which she was supervisor of the Ufficio Monumenti Antichi e Scavi.
In this excavation have been brought to light, at altitude 9,1 Mt asl, more than 5 Mt below the square's foot traffic, the structures of the first Pantheon. It was built by the will of the emperor Augustus, by Marco Agrippa in 26 B.C., in his third consul, as said in the following's Pantheon inscription. Expecially have been recorded two sets of stairs of eleven steps each, built in the pedestal which gave access to the Augustean temple's **porch** and that are situated under the square's actual level, made up by just of seven steps each, being the latest Pantheon's podium, of Hadrian's age, shorter than the old one.
The plan of the Augustan Pantheon was almost identical to Hadrian's: the base of the colonnade, made by wet tuff's blocks (**picture in green**), has been also reused during the reconstruction, naturally elevating it by a new stonework (**picture in red**). It differentiates by a different **porch**'s width: Augustus's Pantheon has a wider colonnade of ten pillars (decastilo), and Hadrian's Pantheon with a 8 columns colonnade (ottastilo).
A survey made in the Claudian/Neronian age (41/68 A.C.), rediscovered in Rome, and preserved now in Vatican's Museums, represent a "decastilo" temple: since there weren't any temple with such number of columns (before the construction, in 135 A.C. of the temple of Venere and Roma), that one may represent the Pantheon. On the pediment are represented Romulus and Remo breastfed by the she-wolf and Rea Silvia asleep and about to be raped by Mars (ierogamia), an explicit hint about the foundation of Rome.
In the great Pantheon's excavations made by Beltrami and Armanini in 1892-93, and amazingly drawn by Georges Chedanne, un pensionaire of the Accademie de France, Augustan structures have been found of the **porch** colonnade which had been interpreted as a temple with a rectangular cell.

Rodolfo Lanciani (denying what previously said), determined and published that the building was structured with a rectangular cell, pointing towards the South of the erected city.
He said that in front of the temple's rectangular structure, there was a circular opening without a cover, fenced in an opus reticulatus wall, with a floor made of antique and pavonazzetto yellow sheets, fine coloured marbles that the romans would've never used somewhere outside. However, today we still find on the internet, on Wikipedia for instance, this same description of the Augustus's Pantheon.
Lanciani, and following studies, negated the existence of a homogenous town-planning scheme, a correlation between Augustans monuments from Campus Martiae, Pantheon, Horologium, Ara Pacis and Augustus's Mausoleum, specifically between Pantheon and Mausoleum. Would be pointless to look for a correlation between two monuments not facing each other and both oriented toward the southern part of the city.
The Pantheon was built in a swampy depression, the Campus Martiae, near the Palus Caprae where, traditionally, took place the ascension and the apotheosis of Romulus and his following transformation in the god Quirino. This choice was not random. Augustus wanted the spot for building the temple, the symbol for the cult of the current emperor, to be the same spot of Romulus divinization, the legendary founder of Rome. Cassio Dio (46,2) writes that was Proclus to see Romulus's ascending the same wonder happened when Augustus died, senator Numerius Atticus earned one million sestertii claiming to have seen the emperor rising up to the sky. Augustus's propaganda was ispired by the "indigenous" models from the origin of the city: Augustus wanted to look like the founder of Rome and tried to replicate, even manipulating the truth, events that took place in Romulus's times. Suetonius describes that Ottavianus "while he was being greeted for his first consul twelve buzzards flew towards him" similar circumstances occurred during Romulus's first ceremony: the flight of these flying animals linked him to Romulus and the crowd had it easier to believe in his authority. Romulus was called "the most august of the wellwishers", and the Senate would confer the name "Augustus" to Ottavianus on the 16th of January 27 B.C., three days later the constitutional reform that would form the empire (was in fact a tradition to reward anyone that acted good toward the republic with a new name). Ottavianus would have preferred Romulus but, being the name of a past king, people could have misunderstood the choice, even the house Ottavianus bought in 36, after the win against Sesto Pompeo, where he lived for more than 40 years, was on Palatino's hill near the Scalae Caci, around the Casa Romuli.
The date of birth too, might be true or not though, was on the 23 of September for both, Romulus and Augustus. Ronald Syme, the historian from New Zeeland, defines as "obsessive" his tendency to relating himself to Romulus. Augustus, a clever, cultured and sly man, as confirmed by his lucky rise to power, understood that the way to reassure the people was by few, repeated symbolic messages. The way the Pantheon is built represent the clearest of all these symbols to Romulus.

2. ASTRONOMY AND GEOMETRY IN THE INNER PANTHEON NL

In 1990 N. Lanciano published «*L'occhio di luce*» a reading of the Pantheon as a solar calendar through the light entering from the oculus, at the solar noon.
She founded
1. The Pantheon has a northward orientation but the axis of the actual monument, of Hadrian's age, is not exactly on the South-Nord line, which means that the solar spot of sunlight is not on the axis of the monument at the solar local noon.
2. The spot of sunlight marks a calendar, in the days of the Equinoxes and Solstices, in addition to the April 21 birthday of Rome, the spot of light is in special architectural points.

Geometry of the inner of the Pantheon.
About the interior shape of the Pantheon M. Yourcenar, in Memoirs of Hadrian, writes: «My intention had been that this sanctuary of All Gods should reproduce the likeness of the terrestrial globe and of the stellar sphere. … This temple, both open and mysteriously enclosed, was conceived as a solar quadrant». (Lanciano 2005). The interior shape of the monument is a cylinder with the base's radius equal to the high, with a semi sphere, superimposed to a cylinder with the same radius. It remembers the form of the roman

and greek roofed spherical sundial with a hole on the top (Gibbs 1976), from which enters the sunbeam, the spherical surface is divided in 12 temporary or ancient hours. There are 12 hours from the Sunrise to the Sunset, and 12 from the Sunset to the Sunrise: the hours of the day are longer in Spring and Summer, while the night hours are longer in Autumn and Winter, and vice versa.
The position of the sunbeam changes with the hours during the day. In the morning it moves from the the edge of the so-called oculus on the west, at the left of the entrance doorway, it falls to the axis of the temple, reaches the minimum height at mid-day, on the north. Then up the dome on the right of the entrance, in eastern part, when the Sun rise, and the spot reaches again the oculus. If the Sun is on the east side of the sky, the sunbeam inside is visible on the western part, if the Sun is south, the sunbeam is north.
However, this way is different every day, and almost the same every year, in the same days: in the year, we have a minimum route in Winter, around the oculus, and a maximum in Summer when the sunbeam reaches the floor. More precisely the highest squares received the noon light on Winter Solstice, near 23 December; the separation between the upper semi sphere and the cylinder receive the big spot of light at the Equinoxes, near 21 March and 22 September, and the ground of the hall, on Summer Solstice in the days near the 21 June. On 21 April, dies Natalis Romae, the light go out from the monument, through the large doorway and the grille over the door, and illuminates the pronaos like a symbol: the light arrives on the city of Rome and on the Empire.
We agree with Hannah and Magli who wrote "We stress that all the astronomical analysis does not aim to show that the Pantheon was designed to make precise measurements of the sun's cycle, but rather to substantiate the symbolic connection of the building with the path of the sun in the course of the year".
Like the difference of the inclination of the sunbeam between the summer solstice and the winter solstice is 47 °, in the Pantheon, that difference can be read, as in a monumental sundial, and architecture creates a memory support.
In addition to this, within the half south of the hall never receives direct sunlight, but the Hadrian emperor was in the south part of the Pantheon to administer justice; he was the only one who could see the spot of light moving on the walls. Who looked at the emperor saw the one who represent the light for the people: the emperor-Elio.

"In this way, the space, with its geometric and cosmological properties refers to universe mechanism of the Stoics, to the numbers of the Pythagoreans and the harmony of the spheres of Platonic. The building, expression of the cosmic order, affirms the supremacy of the sun that illuminates and which is embodied by the central oculus, which holds all the space, as well as the sovereign rules over his empire. This allusion to the imperial cult through architecture that materializes the sun god Zeus-Helios, master of all the gods, of which the sovereign assumes the splendour, is still comforted by the presence of the chariot with four horses, which once surmounted the porch, evoking the course of the star of the day." (Stierlin, 1986)

The numbers that characterise the Temple of all the Gods
Pantheon in Greek means "all the gods": but who are the gods of the Augustus's and Hadrian's Pantheon ? The historian Cassius Dio, writes: "Perhaps it has this name because, among the statues which embellished it, there were those of many gods, including Mars and Venus; but my own opinion on the origin of the name is that, because of its vaulted roof, it actually resembles the heavens." (Cassius Dio 53.27.2) (translation from Latin in Hannah, Magli, 2009). To the main Olympic gods were joined Romulus/Quirinus, Divus Giulio Cesare and the protectors of gens Julia that are Mars and Venus, two of planetary gods.
On the dome, there are 5 concentric circles of squares. Five **l**ike the five planet visible on the naked eyes: Mercurius, Venus, Mars, Iupiter and Saturnus. In addition, we consider also that 5 is the number that the Pythagoreans attribute (link) to Venus (Lanciano 1988).

Every circle has **28** squares like the 28 days of the Moon's month. However, the number 28 has also some numerical special characteristics: it is the sum of the numbers up to 7. In fact 28 = 1+2+3+4+5+6+7 and it is the sum of its proper divisors, so that 28 is a perfect number: 28 = 1+2+4+7+14. The perfect numbers are

integers numbers and they are very rare; the first are 6 – 28 - 496 – 8128 - 33 550 336 (a number to 8 digits). In addition, it is impossible, only with ruler and compass, to divide a circle in 28 equal parts because of the number 7 and 28=4x7.
There is **1** so-called oculus, for the light of the Sun that has **30** roman foots of diameter, about 9 meters.
The hall is **150** roman foots wide, like the Teatro Marittimo in the Adrian's Villa in Tivoli. Also the Big Mosque, in Anna Magnani road, in Rome, made from P. Portoghesi, V. Gigliotti and S.Mousawi and inaugurated June 21, the day of Summer Solstice, 1995, actual headquarters of the Islamic Cultural Centre of Italy, has the same interior shape and the same dimension on the Pantheon.
In the Hadrian's Pantheon, there are **16** niches like the number of the directions in the Etruscan organization of the space; in fact, Hadrian's architecture is very influenced by Etruscan ideas: the Etruscans divided the sky into 16 parts in a clockwise direction: north, east, south and west. They have called lefts ones towards the eastern part of the horizon and rights those on the western part, because they put their deities on the south, so that east is to the left. For them left is positive like the rise, the birth and right is negative, sinister, like the set and the death. In contrast, the Greeks, which placed their gods on Mount Olympus through the north (from the island of Crete), they have the east part on the right, linked to the positive, and the west on the left that is sinister, like for Romans, and for us. (Plinius N.H. II, 143-144)

About the axis
In fact, the light from the oculus is on the axis of the monument some 15-20 minutes before local noon. If we observe the light on the dome at the local solar noon it is on the right of the centre of the door, and the spot of light were on the axes of the Pantheon before this moment. The exact time depends on daily value of the Time Equation, and the longitude of Rome gives a delay of the real sun of +10 minutes. To have a better idea we can consider that there are 28 squares in every circle of the dome, and between a square and another there are 360°: 28 = 12,8°. As if 1° correspond to 4 minutes because 360° correspond to 24 h, the difference between the two positions of the spot on the axis and at noon is of about 4°, which means about 1/3 of square.

We studied also which stars we can see from inside the Pantheon: it depends on the latitude of Rome (near 42° Nord) and on the dimension and height of the oculus. The angle of the cone, from the centre of the hall to the ring of the oculus, around the zenith direction, is about 11° 25', and from the border of the hall, we have a cone with 9° opening. With these data, we can calculate the declination of the visible stars, and planets and Moon, now and in ancient times.

3. **However, why the axis is not Nord-South? PV**

On the **21 of April**, the day Romulus founded Rome, almost 20 minutes before noon the sunbeam directly through the front door of blinding light it's really easy to immagine how Augustus, walking trough the door surrounded that the sunlight would have been seen like a god, by the crowd standing in the square but all this symbolism wasn't over yet, a magical way of light connected the Pantheon to Augustus's Mausoleum, his grave, to remind everyone of the great emperor a unitary city plan to link two monuments, not just symbolically, but phisically. The real connection between the two monuments is made by the two squares in front of them, built parallel to the line from the centre of the Mausoleum to Pantheon's. The square before the Pantheon was exceptionally large and covered with travertine's sheets. Large paved spots have been found during our 1995 excavations but even previously have been seen parts of the paved floor in Rotonda'square and Madddalena's square (documented by archive data G. Gatti).
Lanciani, in his Forma Urbis Romae Tav.8, reconstruct a 60 mt wide, 120 mt long square, even bigger than the current one, which later on will be delimited by the Basilica Alexandrina on the eastern side and on the opposite side by the Therme Neroniane Alessandrine. The northern side has been always left open for the Pantheon to be seen. The square extended to the place, where today we find Coppelle's road/Acqua Santa's road, had the same 5° inclination to Pantheon's front side.

From 2007 to 2010 Virgili directed another excavation by the Sovrintendenza in Augustus Imperators'place, in the Mausoleum and in the surrounding area, founding the bases of the two obelisks that placed side by side with the Mausoleum, locating the Res Gestae Divi Augusti and bringing to light the paved square in front of the grave's opening the paved floor along the line from the Pantheon to the Mausoleum is built to hide not being in axis with the two monuments with few tricks, such as cutting the blocks not perfectly square the Mausoleum was erected at an approximate distance of 739mt from the Pantheon, a symbolic measurement since was equivalent to half of a roman mile, a miliarum (1478.5 m), 5000 roman feet, measurement for the deambulationes, walks told by Svetonio (Aug 100).
The emperor's walk Augustus, every year on 21st of April, crossed Pantheon's portal, enlightened by the Sun rays going trough the omphalos, as a god, started a ceremony, a walk on the paved floors of these two squares in front of the two monuments, perfectly oriented towards one another (both on the symbolic and physic way, that connected the two buildings). From the Pantheon the princes, in about 20 minutes, four minutes every solar degree, after half roman mile, reached his Mausoleum, oriented on the north-south axis, perfectly in time to see the Sun shining on his tomb, garnished by a wonderful golden-bronze statue.
Both by architectonic symbolism and astronomy, Augustus's architect have told to the people the godly origin of their emperor.

4. The Horologium and the Ara Pacis

In the urban complex of Augustus is inserted also the monumental sundial or Horologium mentioned by Pliny in the Naturalis Historiae (N.H., XXXVI, 72 ss).
In Egypt obelisk is the same name of sunbeam: in Rome this obelisk, brought from Heliopolis in 10 B.C., is dedicated to the Sun and therefore to Apollo, the Augustus's protector.
The day of the Equinox 23 September, day of the birth of Augustus, the shadow of the obelisk of the Campus Matius, at sunset, reaches the Ara Pacis , like we can see in the model in the Ara Pacis Museum.
Augustan meridian line in Campus Martius 1979 partially excavated by Buchner in 1979 with the location and function of the Ara Pacis: recent research lead to exclude some hypotheses still present, with the relative figures, in many articles and in the web. The meridian line was certainly marked on the ground but the others hour lines, as if we can see in the first Buckner reconstruction of 1982, there were probably not, and even declination lines. (:::::) It means that the space occupied by the monumental meridian line, with an obelisk of about 30 meters, was a long strip, of about 66 meters, width of about 2 meters. And not a network full on lines
The same **obelisk** is, from 1990, the gnomon of a new meridian line in Montecitorio Place. The obelisk is not in the same position than before. Because of the dimension of the place and the position of the obelisk, relative to the building façade on the north, not all the calendar, from one solstice to the other, in marked on the ground. We found dates from Summer Solstice to November and, on the other side of the meridian line, from February to Summer Solstice: it left the part of the year near the Winter Solstice.

The **Ara Pacis Museum**, in its twentieth-century accommodation, is located near the Augustus's Mausoleum, between Ripetta road and Cavour Bridge in a great Teca of the architect Richard Meier. Inside the Teca there are the Ara Pacis, and a model of the Campus Martius at the time of Augustus: toward the northern edge of the area there is the Augustus's Mausoleum, in the centre of the campus Augustus's ustrinum, on the east side the Flaminia road, the Saepta Iulia and the Pantheon (27-25 B.C.) located further south. There is the Ara Pacis in its original position and the Horologium, or meridian line indicating the mid-day in the seasons, with the obelisk. The Pantheon is close in shape and size to the Hadrianic building but with a wooden roof, and 10 columns in the front like in the Augustean building.

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It is also to assume a different position for the Ara Martis