

Digital Survey and Investigations into the Shape of the Ribbed Vault of the Serapeo at Hadrian's Villa (Tivoli, Italy)

Sergio DI TONDO¹ – Silvia NICOLI²

University of Florence, Firenze, Italy

¹sergioditondo@ndas3a.it

²nixilvia@tiscali.it

Abstract

Hadrian's Villa (the *Villa Adriana*) – built in the second quarter of the second century A.D., is a World Heritage site and one of Italy's most famous and popular archaeological sites – is still the object of excavation and research, which periodically allows us to improve our knowledge about numerous unknown or neglected parts of the villa. Among the elements to be studied in detail some are linked to the morphological conception and the building technique known as the “*volte a ombrello*”. A very well-known example of this covering solution is the ribbed vault of *Serapeo*. This vault of the villa has been largely documented by drawings that always show the presence of a massive collapse of the front towards the long *Euripo* of the *Canopo*. The collapse led to a structural loss, which in part compromises our ability to understand the design made by Hadrian's architects. In September 2007, a survey was undertaken using laser scanner technology in order to document the morphology of the collapsed parts, giving important evidence of the original shape of the building. The aim of this project is to comprehend the building's shape and the characteristics of the principal facade. For this purpose a survey was undertaken resulting in the documentation of the building's large vault, the collapsed fragments, and the side halls. The aim was to create a reliable reconstruction, not one derived from typological comparisons. The digital survey permitted us to develop a hypothesis about how the structure should be restored, which would have been impossible to achieve using traditional instruments and methods. Once the point cloud model had been turned into a surface model (mesh), the generating arches and the web's directrix (constituting the ribbed vault, shaped like an umbrella) could be identified. The virtual replacement of the collapsed parts has confirmed the hypothesis about the nature of intrados surfaces of the dome, giving an important indication about the principal facade of the building. This outcome makes a virtual or real restoration of the edifice possible, or it could provide a source for studying other hypotheses about the original design of the *Serapeo*.

Keywords

Remote sensing: Geophysics, LiDAR, Satellite Images GoogleEarth; 3D Data capture and visualization, Virtual reconstructions and visualization: Problems with uncertainty; Archaeological theory and computers: Beyond the quantitative debate

1. Introduction

In September 2007, the Florence Department of Architectural Design¹, in collaboration with “Premio Piranesi”², and Archaeological Heritage of Lazio Office³ succeeded in carrying out a digital survey of the entire complex of the Serapeo at Hadrian's Villa (Fig. 1). This activity is a part of a larger research project undertaken by the Florence Department of Architectural Design, started in 2004, which aims to document the principal pavilions of the Hadrian

complex by means of 3D models. During the past few years the Department of Architectural Design at the University of Florence made the following digital surveys. 2004: survey of the monumental complex of the Great Bath and the Great *Vestibolo*. 2005: the Gymnasium complex (which is today the object of archaeological excavation) and a part of the *Cento Camerelle* along the street leading to *Vestibolo*. 2007: the monumental complex of the *Serapeo* and the octagonal room in the Small Thermal Bath. Furthermore, a topographical net was created to

¹ University of Florence, Department of Architectural Design: Director prof. Ulisse Tramonti. Section Architecture and drawing, Responsible of survey laboratory prof. Marco Bini. Topographical survey coordinator arch. Mauro Giannini, arch. Francesco Tioli. Laser scanner survey: coordinator dott. Giorgio Verdiani, Carlo Battini, Sergio Di Tondo, Filippo Fantini, Stefania Iurilli, Silvia Nicoli, Stefania Pini.

² Premio Piranesi 2007 “Yourcenar”: director prof. Luca Basso Peressut, coordinator prof. Pier Federico Caliarì.

³ Archaeological Heritage of Lazio Office: Soprintendente: Dott. Marina Sapelli Ragni; Ispettore: Dott. Benedetta Adembri.



Fig. 1. Hadrian's Villa: view of Canopo and Serapeo.

connect all the surveys and a topographical survey of details of some pavilions of the *Villa*, the *Porticus Pecile*, the garden nymphaeum near the Small Thermal Bath, the building called the *Antinoeion*, and the *Canopo*.

The digital survey of the Serapeo (made by a FARO 80.80⁴, a phase-shift laser scanner), (Fig. 2) made our documentation of both the inside and the



Fig. 2. 3D digital survey: laser scanner (FARO 80.80) is working under the Serapeo's large vault.

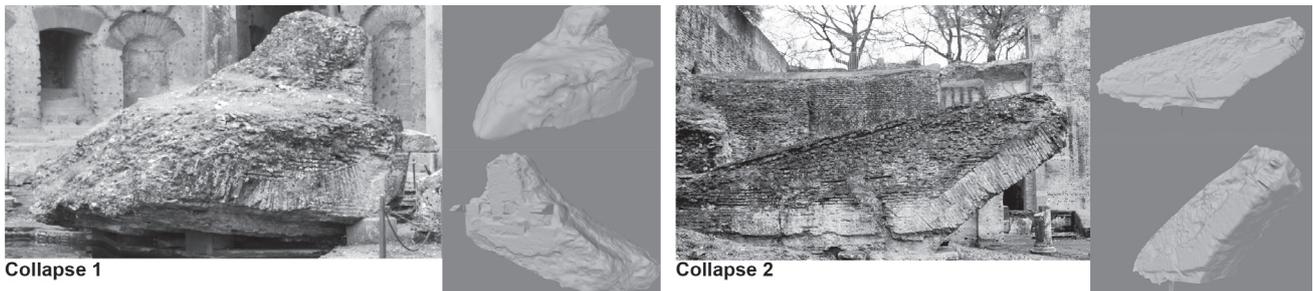


Fig. 3. The state of conservation of the two collapsed blocks from the superior side of the vault and the models obtained by means the digital survey data.

Today the first block is still in its original position, i.e. at the vault base inside the rectangular basin of the Euripo. The second, moved during the post-war restoration, is now placed along the left side of the Canopo.

outside of the entire monument (with the exception of the contemporary deposit of the German Archaeological Institute) very accurate. The scanning skillfully registered in one digital 3D model (with the help a topographical net) allowed us to review not only the morphological characters of the complex, but also the thickness of walls and the relations between the different levels of the building. This last feature of the digital survey is particularly important for understanding the monument as a huge scenographic machine full of plays of water. This was, in fact, the way the structure had been used by the emperor during his fabulous banquets⁵. Of particular interest was the analysis of the relationship between the plumbing system⁶ and the innumerable inner courts (*cavaedia*), which might help us uncover the real purpose of this enormous scenographic fountain.

2. Principal aims

Concerning this research, our investigation focused exclusively on the morphological characteristics of the Serapeo's facade. The study started with the elaboration of the digital survey data. During the survey different 3D models were made of the building and of the two nuclei in *opus caementicium*, from the collapsed ribbed vault.

3. The principal facade of the Serapeo

The digital survey campaign aimed at documenting the Serapeo included two collapsed blocks from the superior side of the vault, made of *opus caementicium*

⁴ Here we would like to thank AREA 3D of Livorno for their invaluable contribution during the survey operations.

⁵ Once the hypothesis of Serapeo of Villa Adriana as a temple for Iovis Serapis was discarded, it was replaced by a new hypothesis that this place had been dedicated to banquets and leisure activities (*otium*) of the emperor and his guests. Cf. Ricotti 2001, 241–263. Cf. Cinque 2008, 199.

⁶ The Serapeo and the building called Palestra along the Valley of Tempe, were probably the only buildings of Hadrian's Villa endowed with direct access to the water source. On the Serapeo see Mari 1991, 159–160.

and bricks (Fig. 3). The first block is still in its original position, i.e. at the vault base inside the rectangular basin of the *Euripo*. The second, moved during the post-war restoration (Aurigemma 1954; 1955; 1956)⁷, is now placed along the left side of the *Canopo*, under the *substructiones* wall of the high ground. Both collapses have been documented by several authors. In 1768 Giovanbattista Piranesi made several engravings of the Serapeo during his survey of the villa. One shows the hemicycle and the two collapses seen close up. (Fig. 4) This engraving appears not to be reliable from the morphological point of view because both collapses are identically represented and are symmetrical to the accidental point of the central projection.

The comparison between Piranesi's engravings and the surveys Louis Marie Henri Sortais made between 1860 and 1911 (Jacques *et al.* 2002, 139–152) confirms our hypothesis that Piranesi is unreliable. Sortais documented both collapses in the plans and the longitudinal section, (Fig. 5) and he highlights a relevant difference in dimension between the right collapse (the one that is still in its original place) and the left one (the one moved after World War II). Thanks to Sortais it is also possible to observe how the morphological characteristics of the right block are almost totally preserved while the left one's shape and dimensions seem notably modified.

The photos made during the restoration of 1951 show the state of preservation of the two concrete nuclei. During the excavations, Salvatore Aurigemma

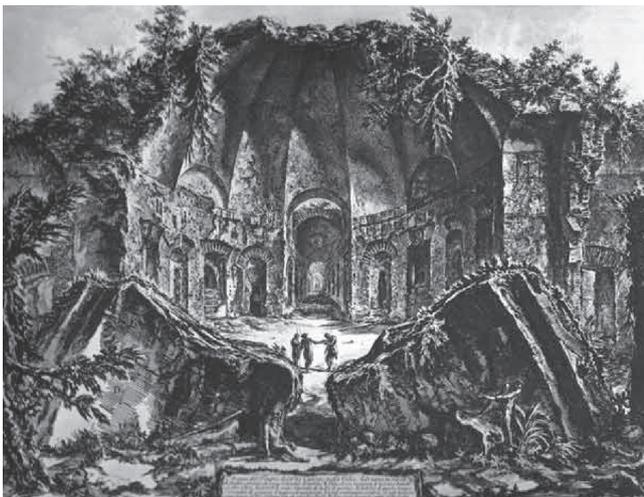


Fig. 4. Giovanbattista Piranesi 1768: engraving showing the hemicycle and the two collapses.

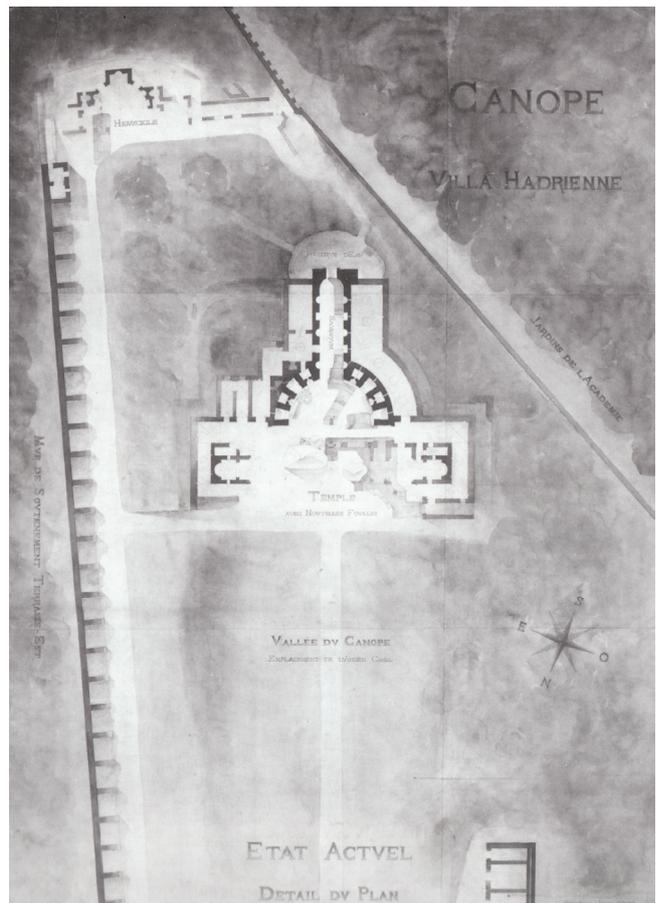


Fig. 5. Louis Marie Henri Sortais 1860–1911: engraving showing the hemicycle and the two collapses.

noticed that the left block had collapsed before the right one because the left block is partly placed in the bottom of the rectangular basin, while the latter was on a huge layer of earth (Aurigemma 1954, 329–330). As a result, the left-hand collapse needs a solid underpinning in order to avoid overturning during excavations (Gizzi 1999, Fig. 50).

The pictures show that the right collapse has preserved its shape, dimensions and position in the basin, while the one on the left has changed. Nonetheless, the important and characteristic elements of the nucleus in *opus caementicium*, illustrated in Aurigemma (Aurigemma 1954, 328), have remained unaltered. In fact, it is only the left block that still presents its relieving arch and both of them have preserved traces of little shelves. This element, highly evident in the 3D digital model, has proved useful in determining the original location of the collapsed mural blocks. Moreover, since the right one is still in its original position, it can show the dynamics of the collapse: the collapsing material

⁷ The interventions in 1951, undertaken by the school yards of the Ministero del Lavoro and Ministero della Previdenza Sociale, were also important.

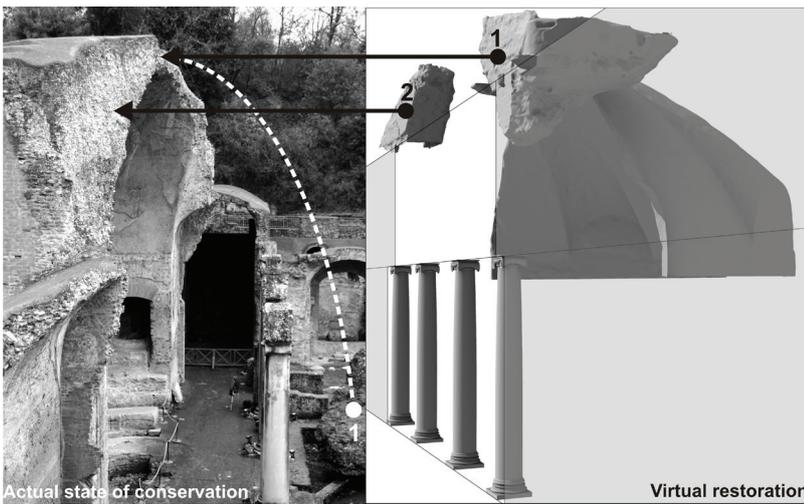


Fig. 6. The hypothesis of virtual restorations of the two collapsed blocks.

rotated 180 degrees as described by Aurigemma (Aurigemma 1954, 300) (Fig. 6). This means that it is possible to appreciate the intrados of the collapsed vault, while the extrados is the base of the whole

block leaning on the modern blocks of concrete.

The shelves found in both the right and the left parts allowed us to distinguish between the internal and external sides; and also to establish a first mutual alignment. The left portion of the relieving arch suggests several hypotheses regarding the facade. In this case two different solutions have been proposed. According to the first one, (Fig. 7) the spring of the relieving arch should be close to the two columns leaning against the external wall of the long barrel vaulted corridor. The

second possibility (Fig. 8) is to put the spring of the arch right on the wall, leaving to the columns only the weight of the entablature. The more probable solution seems to be the second not only because it confers to

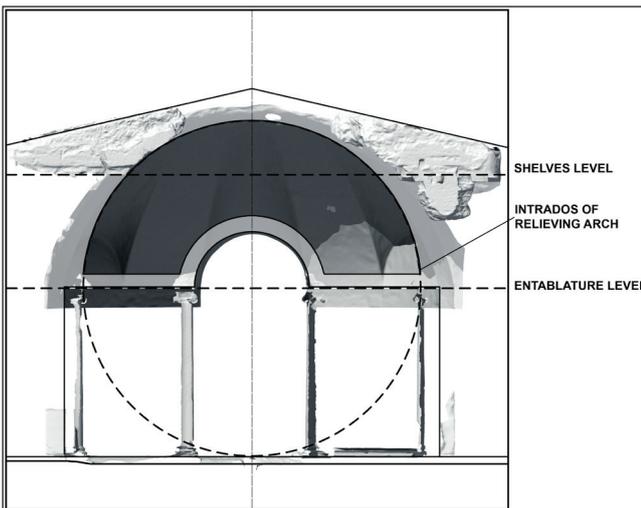


Fig. 7. First proposal for the Serapeo's facade.

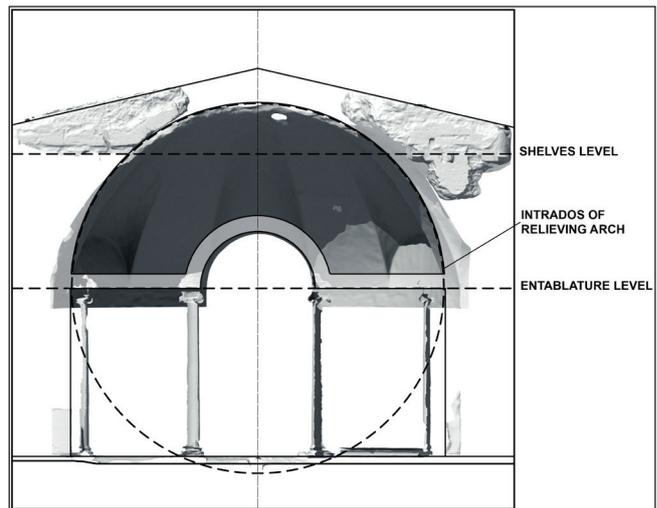


Fig. 8. Second proposal for the Serapeo's facade.

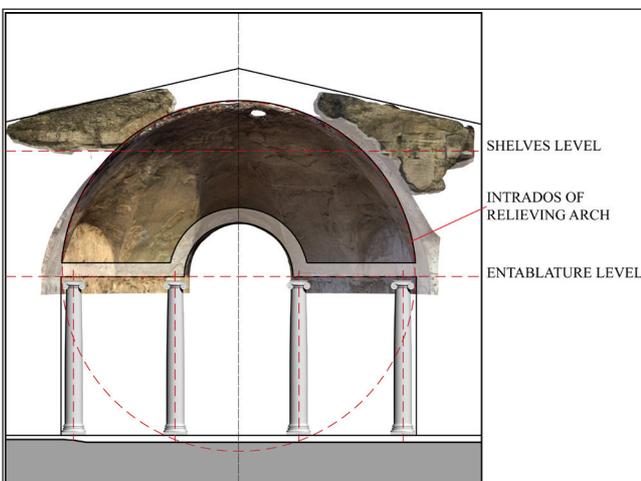


Fig. 9. Second proposal for the Serapeo's facade, using a 3D textured model. The picture clearly show the shelves and the relieving arch used to establish a first mutual alignment.

the facade a less stumpy aspect, but also because it is compatible with the other solutions found inside the monumental complex of Villa Adriana (Fig. 9).

However, both hypotheses highlight the rectilinear shape of the top of the facade, suggesting the presence of a triangular tympanum. The architectonic resolution of the round arch, under a triangular tympanum, was surely known by Hadrian. It was indeed present on the triumphal arch made for him in 129 AD in Jerash (Jordan). Given this fact, it is useful to reconsider the various hypotheses about the reconstruction of the Serapeo's facade (Fig. 10) proposed by Canina (Canina 1856, tav. 166; Aurigemma 1996, 102), Sortais, Mastrosanti, Delvapois, Mirri, Signorini (Gizzi 1999, 26) and Apolloni-Ghetti. In contrast to the physical model by

Gismondi (exhibited at the visitor orientation center at the entrance to the Villa), in which he introduces a triangular tympanum quite similar to that suggested by our investigation, all these reconstructions have a round pediment analogous to the temples in the Egyptian style or connected with an Egyptian cult of the Hellenistic tradition⁸. The remarkable amount of finds in the Egyptian style discovered near the Canopo Serapeo must have influenced the reconstruction of the facade.⁹

These hypotheses agree in reconstructing the facade with a round gable, and they also show the same solution of a relieving arch, springing directly to the long barrel-vaulted corridor, which leaves open

the facade and gives the columns and the entablature the role of a filter between the inside and the outside. The various authors cited differ only about the shape of the entablature. Canina and Sortais proposed a rectilinear solution clearly inspired by the *Teatro Marittimo's* entablature (Fig. 11); Gismondi and Apolloni-Ghetti present a solution with a "Syrian" or "Palladian" arch inspired by the temple facade at Ephesus built by Hadrian. The fragments found *in situ* and the current *anastylosis* are not able to give us a definitive solution to this problem. In our case the choice of a *Serliana* entablature exclusively depends on an intuition and not on concrete data.

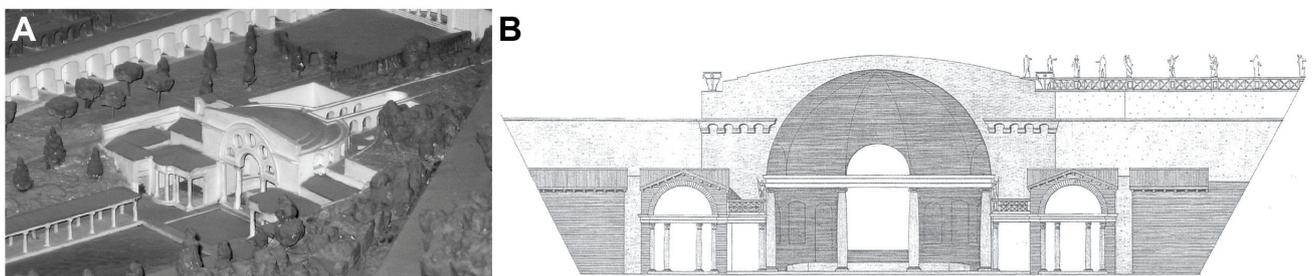


Fig. 10. Two proposals for the Serapeo's facade: (A) solution proposed by Gismondi (1957), (B) solution proposed by Mastrosanti, Delvapois, Mirri, Signorini (2nd half of the 1950s).

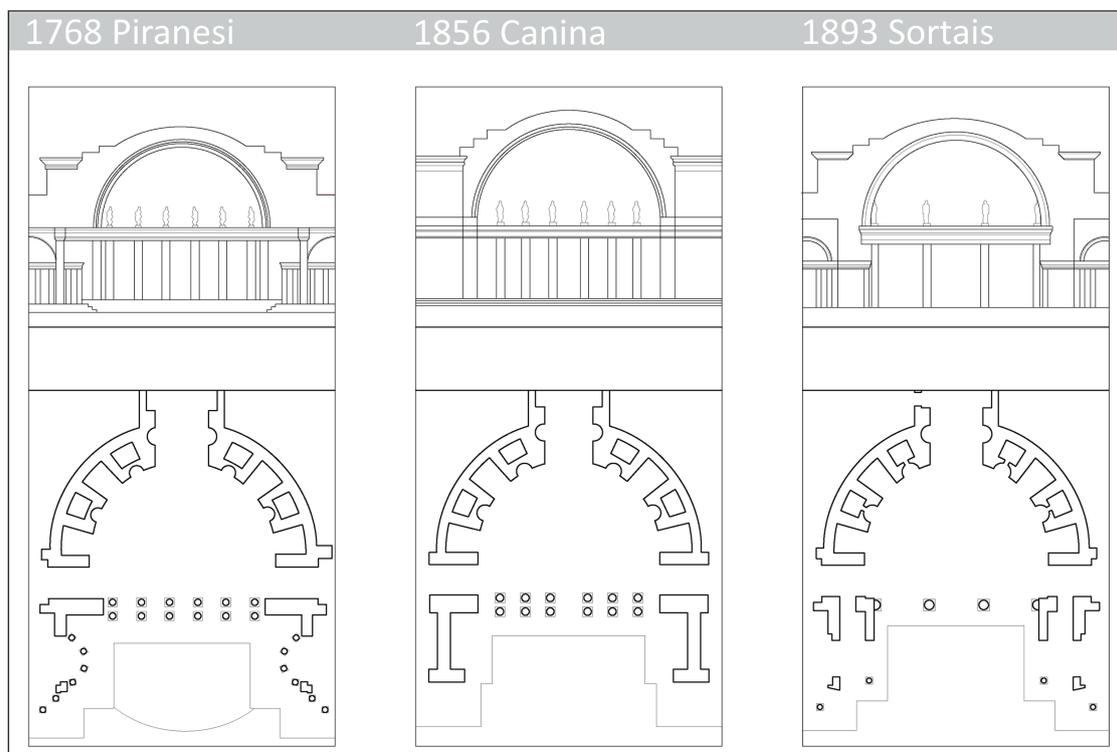


Fig. 11. Three proposals for the Serapeo's facade and plan.

⁸ Cf. the architectural solutions in the Nile Mosaic at Palestrina where the temples are represented with the characteristic facades containing the reduced arch.

⁹ Cf. the large collection of Egyptian material from Hadrian's Villa in the Egyptian Gregorian section of the Vatican Museums.

4. Conclusion

The digital survey and the possibility to use reliable 3D data allowed us to revisit a problem of great interest since the 1950s.¹⁰ The use of digital technology allowed us to discover some hitherto unknown facts about how the surviving ruins can be reassembled, and this in turn permitted us to propose a more accurate reconstruction of the principal facade of the Serapeo, one of the most memorable and important components of Hadrian's Villa.

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¹⁰ We refer to the proposals for the replacement of the collapses documented by the correspondence among Roberto Vighi and Prof. Piero Romanelli, Soprintendente alle antichità, Foro Romano e Palatino, dated 2 December 1955. Gizzi 1999, p. 67.