

# Construction and Conception Techniques of Residential Buildings and Urbanism in Medieval Europe around A.D. 1100: The Example of Cluny (France)

Bernhard Flüge

Everybody knows that the Burgundian abbey of Cluny was one of the intellectual and spiritual centres of Europe during the High Middle Ages. But also the surrounding little town is of scientific interest. Its earliest, partially preserved upright standing habitable stone buildings were discovered and documented by the author in the last two decades. The results of this study help to explain the formation of the European town house and town texture in France, Southern Germany, and Italy—even Rome, in the mediaeval period. The specific construction and conception of these houses leads to new conclusions concerning building practices, extending to urbanism and space mastering, apparently based on Roman construction practices and conception instructions.<sup>1</sup>

## The “House with the round arch gate” from 1090/91 (d)

The “house with the round arch gate”, from 1091 according to dendrochronology, is the oldest precisely dated stone townhouse in France (Fig. 1).<sup>2</sup> This house has been integrated in a texture of mediaeval and post-mediaeval serial houses characterizing Cluny’s old town since the later 12th century. The ground plan of the original house appears in rectangular shape in the back part of the present building area. The building differs with two marked typological properties from the well-known Romanesque houses in Cluny, which were all definitively constructed after 1150.<sup>3</sup> First, it was originally a freestanding rectangular building; its reconstruction requires a completion by exterior stairs. Second, it was separated from the street by a frontcourt, documented by an archaeological survey in 1997. The existence of an upper floor is an important typological feature that characterizes all town houses in Cluny as “*domus solaratae*”.<sup>4</sup>

The construction of the house consists of double shell masonry. The stones correspond to the local material used for the construction of Cluny Abbey, but are of smaller size, and were thus certainly less expensive. The arch keys of the gate are comparable to the Eastern parts of the abbey church Cluny III and may attest the accepted dating in the year 1095 for the choir. Concerning the petit appareil masonry, the small stones were shaped approximately in a block form by a big hammer, a common technique, dating back to Roman times,

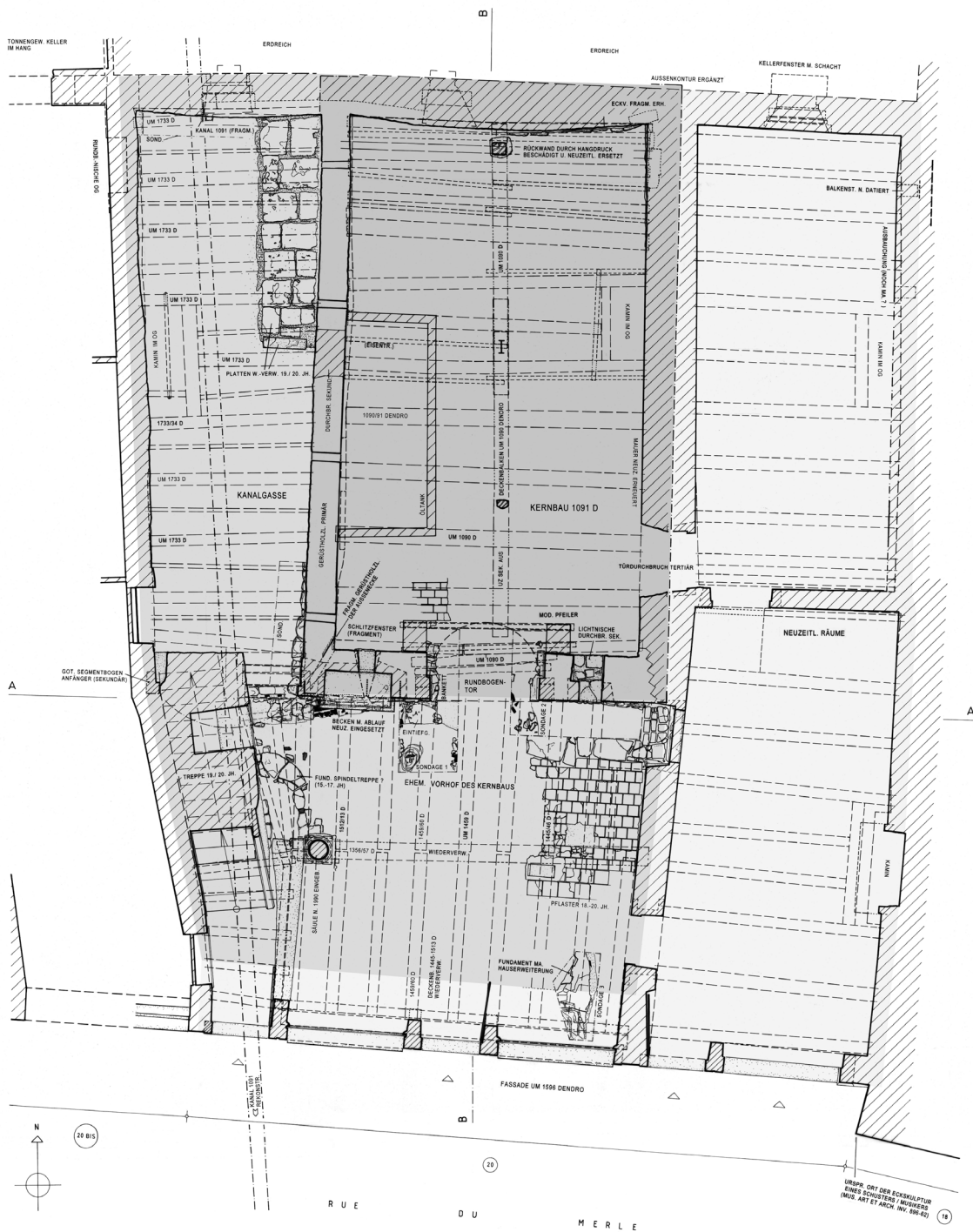
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1 Cf. detailed analysis in Flüge forthcoming. The present article abstracts some of the main research results and focuses them to a new view of mediaeval building and planning practices, that seem essentially based on late antique knowledge.

2 Archéolabs réf. ARC 99/R2138D, ARC 99/R2138D/2, ARC 02/R2767D/1.

3 Cf. Flüge 2011, passim. The article outlines a novel typology of mediaeval residential buildings (houses and palaces) in Cluny as examples of a European development (for detailed analysis cf. Flüge forthcoming, esp. Kapitel V, “*Domus solaratae* der Periode Cluny III – Typologie” and appendix, documentation pl. 1–50).

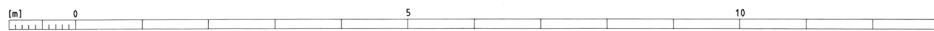
4 Concerning the introduction of this historically sourced term, cf. Hubert 1990, passim, in particular 170–179 and 232.



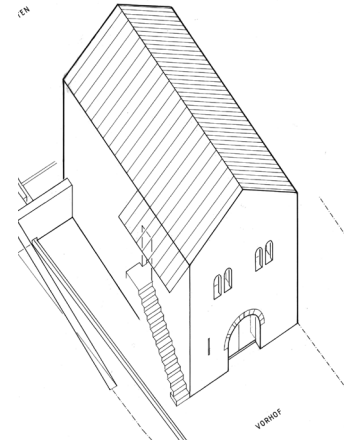
CLUNY: 20, RUE DU MERLE

„HAUS MIT RUNDBOGENTOR“ VON 1091

GRUNDRISS ERDGESCHOSS



	UM 1091
	UM 1300
	UM 1596



**Fig. 1:** Cluny, house 20, rue du Merle.

**A.** (Previous page) Plan with building evolution. Documentation Pl. 7. Drawing: Bernhard Flüge.

**B.** (Above left) Façade of the initial building (Kernbau) from 1090/91 (d) after readaptation of the surrounding level. Photo: Hans-Peter Wieser.

**C.** (Above right) Initial building from 1090/91 (d). Isometric reconstruction, view from SW. Documentation Pl. 22. Drawing: Bernhard Flüge.



**Fig. 2:** Comparison of masonry techniques (clockwise from top-left).

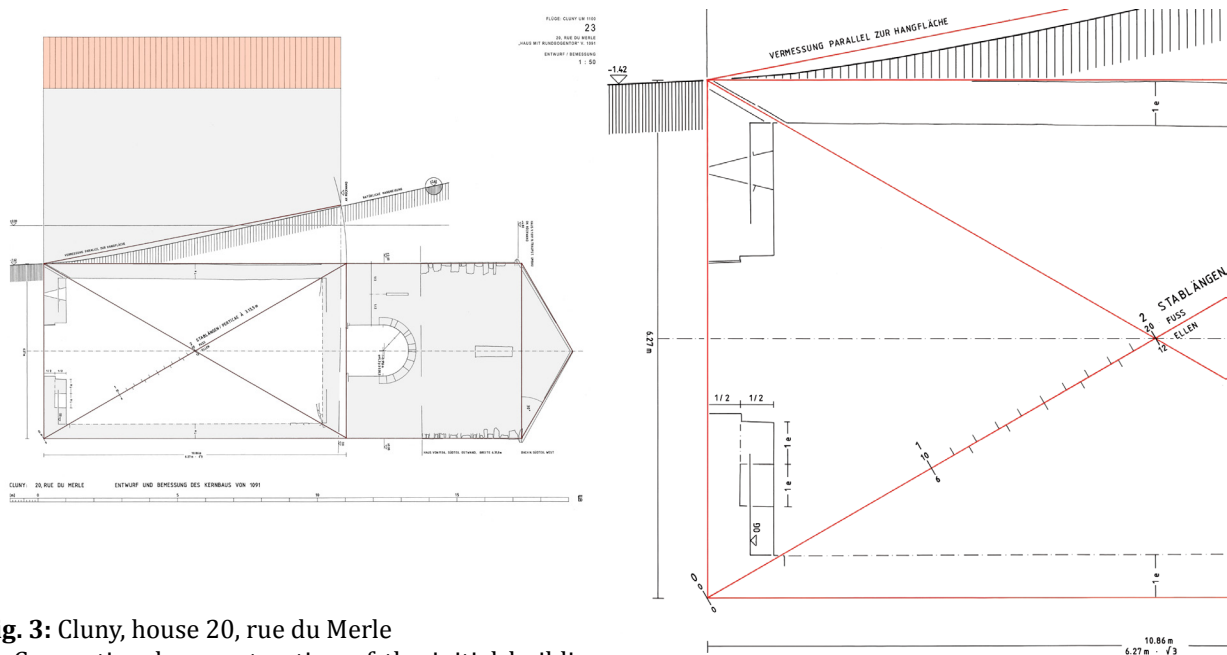
**A.** Cluny, house 20, rue du Merle. Initial building from 1090/91 (d). External West wall. Characteristic petit-appareil masonry in long courses of oolite stones with insular micrite elements. Micrite is absent in the Cluny houses of the 12th century and later. Photo: Bernhard Flüge.

**B.** Cluny, house 20, rue du Merle. Initial building from 1090/91 (d), front side. Masonry and single-course foundations. Photo: Bernhard Flüge.

**C.** Augusta Raurica, external wall of the theatre. Petit-appareil masonry (stones shaped as blocks by a hammer) with pietra-rasa plaster and stiltatura. Photo: Bernhard Flüge.



particularly in the provinces of the Roman Empire. Perhaps the use of the hammer, called *la mace* in old French, derived from the popular Latin word *mat(t)ea*, was so characteristic for the craftsmen, that an etymological relation between *mace*, “hammer”, and *maçon*, “mason”,



**Fig. 3:** Cluny, house 20, rue du Merle

**A.** Conceptual reconstruction of the initial building

from 1090/91 (d). Documentation Pl. 23. Drawing: Bernhard Flüge. **B.** Documentation Pl. 23, detail. Drawing: Bernhard Flüge

may be established: Both terms have been transmitted since the 12th century.<sup>5</sup> The masonry is arranged in long courses of fluent and slightly moving appearance (Fig. 2). It is bonded by an earth or loam mortar, which actually characterizes the period, and contains only few additions of lime and sand. The foundations are remarkable, because foundation trenches do not exist. This phenomenon could trace back to the older local building tradition, with wooden sill-and-post constructions.<sup>6</sup> The foundation of the house consists of one only brick-course just put on the ground, whilst the houses built in Cluny from the 12th century forth dispose always of foundation trenches. Another difference is the appearance of wood within the connection of the house from 1091, so the lintel of the gate and a wall plate serving as support for the ceiling beams. Ashlars are exclusively used for openings: the radially dressed arch stones were certainly fabricated in the masons' workshop of the abbey. Some vestiges of wall plaster have been preserved in the interior of the house. It is a *pietra rasa* plaster, executed after an originally Roman technique. This plaster can be imagined similar for the interior and exterior building surfaces. With a depth of 80 cm, the front of the house is the thickest wall. It contains the biggest stones, and the round arch's depth almost matches the dimension of the sidewalls. The position of the gate is absolutely symmetrical. The house front contributes a monumental feature to the small building. All these details express a representative ambition of the architecture, attained with a maximal cost effectiveness.

The rectangle of the ground plan is 6.27 m on 10.80 m large and was defined by two diagonals of similar length (Fig. 3). The diagonals contain approximately the double breadth of the front, with a contraction difference of 8 inches. The declivity of the natural terrain ex-

5 Cf. Dauzat 1971, 434 (with a different etymological proposition for *maçon*) and 450 besides <<http://ielex.mpi.nl/cognate/2068/>>, 08/17/2012, (*mat(t)ea*).

6 For vestiges of wooden constructions, cf. Roiné 1988/1993.

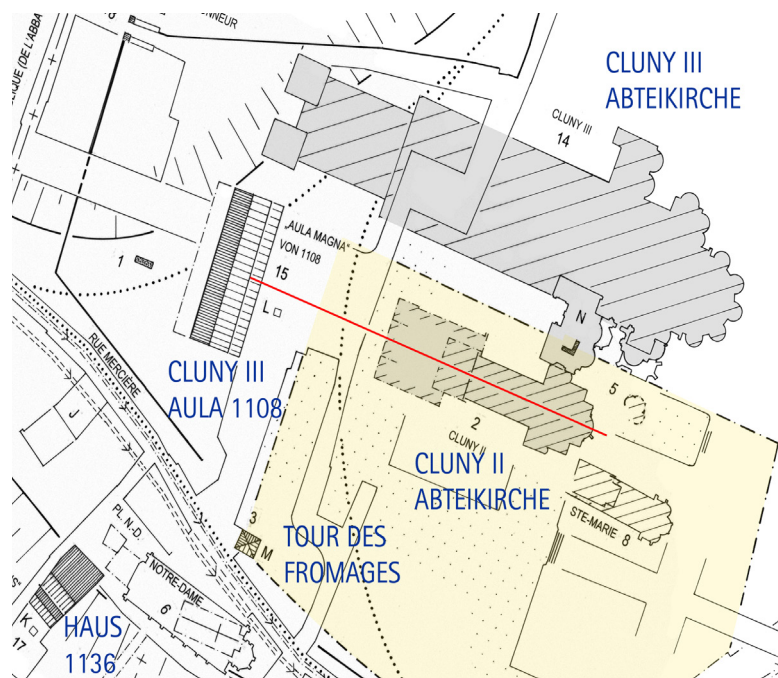
plains this difference: The house was not laid out after a horizontal projection like in modern times, but directly on the 11 degree inclined surface of the natural ground, according to the topography. The horizontal projection length of the plan appears as the shorter side



**Fig. 4:** Cluny III, Aula from 1107/08 (d). Eastern eaves side (front of the building) and lateral South wall, tympanum with lion sculpture. Photo and layout: Bernhard Flüge.

adjacent to the inclined hypotenuse line on the terrain surface, if both lines are imagined to form an angle in the longitudinal section of the building. The half breadth of the house from 1091, 3.14 m, can be interpreted as 1 perch, equivalent to about 10 feet or 3.4 yards. These basic units correspond to the dimensions of several independent architectural elements of the house, such as niches. Only the arch of the gate seems to have been dimensioned with a smaller measure-of-foot, around 30.4 cm instead of around 31.5 cm. Like the longer foot, the smaller unit appears also elsewhere

in Burgundy. The presence of two slightly differing dimension systems, corresponding to the contributions by different guilds to one same construction, is one of several particular examples for the flexibility of building practices around A.D. 1100.



**Fig. 5:** Cluny, Abbey. Axial correlation between aula III and abbey church II. Documentation Pl. 1, detail. Drawing: Bernhard Flüge.

### The “Aula imperialis” of the Cluny III period from 1107/08 (d)

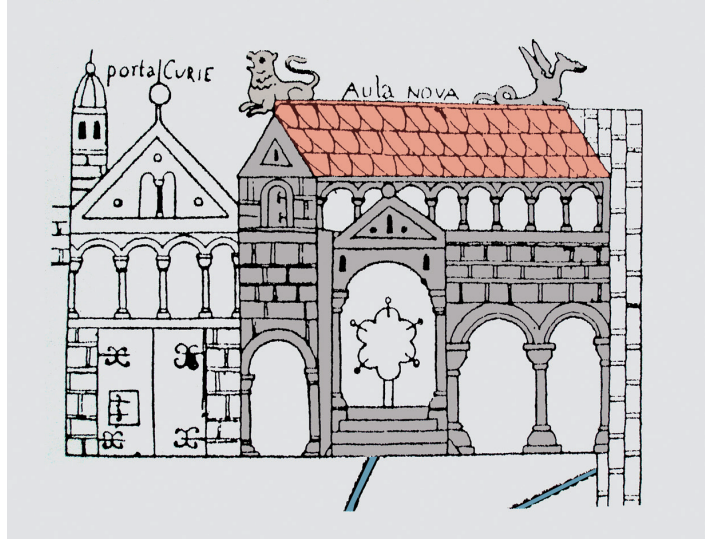
Twenty years after the beginning of the construction site of Cluny III, around 1088, the second tallest building of the mediaeval abbey was erected: the so-called “Écuries” or “Hôtellerie de Saint Hugues” (Fig. 4). Scholars have considered this building as a guest house. But it is not a guest

house type, nor does the Cluniac guest house seem to have been situated at the Écuries’ place.<sup>7</sup>

The rectangular Écuries hall building is composed of a basement and a main level, 53 m long, nearly 15 m wide without annexes, and nearly 16 m high under the roof. Windows are arranged on three sides, the long east front and the lateral north and south gable walls. Together with the central gate of the long front and the pillar axes in the interior of the basement, the windows distribution defines a transversal orientation of the hall building. The presence of a big hall with basement, the transversal orientation of the building, and the former presence of annexes, e.g. with stairs and a big loggia, correspond to a palace, and more precisely, to an *aula* type.<sup>8</sup> The transverse axis of this *aula* adopts the longitudinal axis of the Cluny II abbey church, situated on the opposite side of the main abbey court (Fig. 5). The mediaeval author Gilo writes about an *Aula imperialis*, which the Abbot Hugues de Semur had begun shortly before the end of his lifetime (he died in 1109). This information does not

7 For the typological definition of the Écuries, see Flüge 2011, 300–303. For typology and location of aula and guest house, the 12th c. Canterbury plan (“Eadwine Psalter” (around A.D. 1155–70), Cambridge, Trinity College, Ms R.17.1 fol. 285) may be compared to the buildings and sources of Cluny. This discussion is part of the author’s thesis (Flüge forthcoming).

8 Cf. Günther Binding in *Lexikon des Mittelalters* I (1999), col. 1234: The term “*aula*” designates “[...] seit merow[ingischer] Zeit zumeist einen profanen Saalbau bzw. die Abtswohnung (St. Galler Klosterplan), jeweils gleichbedeutend mit palatium, seit karol[ingischer] Zeit vornehmlich profane Anlagen mit einem Saal im Obergeschoß, in Pfalzen die aula regia mit dem Saal des Reiches (Aachen, Ingelheim, Frankfurt, Goslar). Als Bauform ist die karol[ingische] aula regia ein querrrechteckiger, zumeist ost-west-gestreckter Bau mit Untergeschoß und einem über ein solarium (wohl teilweise hölzerner über Außentreppe erreichbarer Vorbau) zugängl[ichen] Obergeschoß, dessen Decke oder offener Dachstuhl von einer Mittelstützenreihe getragen wird. [...] Der quergerichtete Saal wird auch in otton[isch]-sal[ischen] (Paderborn, Bamberg) [...] beibehalten und in den Palas auf Burgen übernommen [...]”



**Fig 6: Lion acroteria**

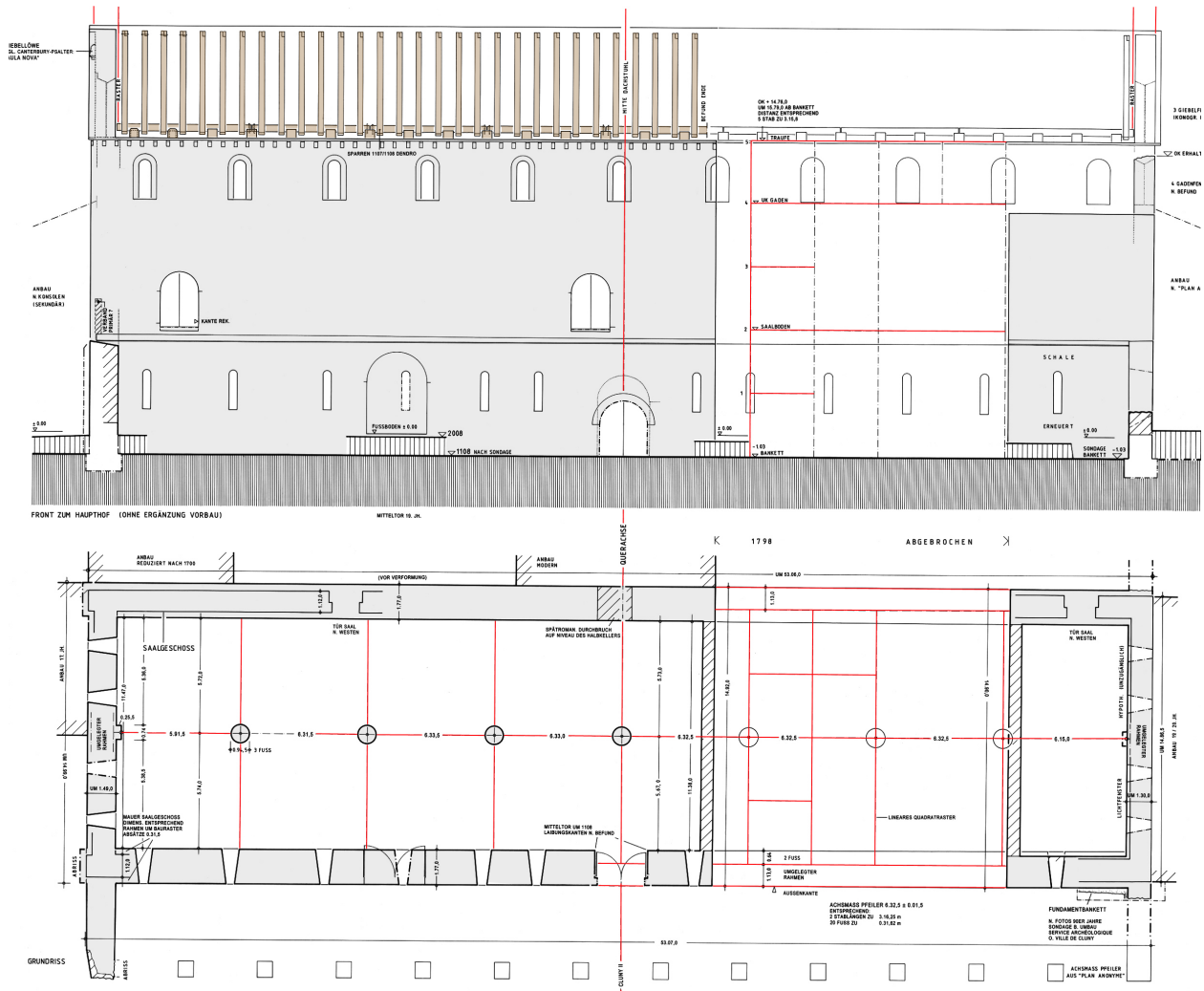
**A.** Cluny III, Aula from 1107/08 (d). South gable wall with corner lesene, console cornice, and tympanum lion relief. Remarkable: the slight prominence of the tympanum surface in relation to the clerestory. Photo: Bernhard Flüge.

**B.** The 12th c. "AULA NOVA" with lion and dragon acroterions in Canterbury. Representation of the cathedral domain in the "Eadwine Psalter" (around 1155–70, Cambridge, Trinity College, Ms R.17.1, fol. 285). Historical graphic rendering with unprecise legend reproduction (after Benevolo 1983, 186, Fig. 515, without signature; colour layout: Bernhard Flüge).

mean, in my opinion, that the Écuries was, as is claimed, a metaphoric "imperial habitation",<sup>9</sup> but rather was a new *aula*, a palatium-type building, which has dated by dendrochronology to A.D. 1107/08.<sup>10</sup>

<sup>9</sup> For this interpretation of the Latin terms *aula imperialis* ("kaiserliche Wohnung"), cf. Wollasch 1996, 171.

<sup>10</sup> Dendrochronological dating by Christian Dormoy, by request of the author. References: Archéolabs réf. ARC 06/R3275D and Archéolabs réf. ARC 06/3275D/2.

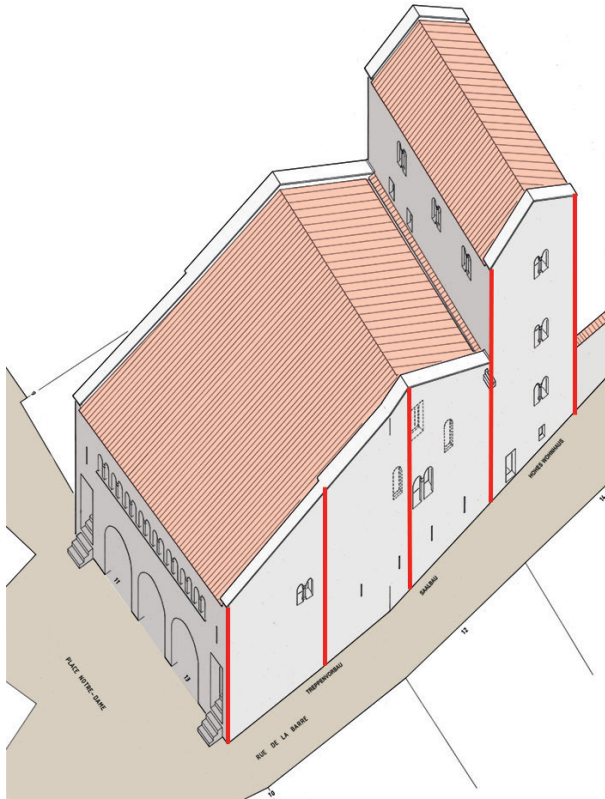


**Fig. 7:** Cluny III, Aula from 1107/08 (d). Ground plan, frontal view with roof structure and geometrical square grid for proportion and dimensioning of the building. Documentation Pl. 40 (detail). Drawing: Bernhard Flüge.

Its efficient realization within the construction site of Cluny III might be one of the reasons that the *aula* has not been identified during decades of archaeological interventions: The building features few sculptures, only a three-sided console cornice under the roof, and the relief of a lion in the southern tympanum. A comparable lion sculpture existed in the aula of Canterbury and is represented in the 12th century Canterbury plan as an acroterion on the roof of the “AULA NOVA” (Fig. 6).<sup>11</sup> In the Cluniac *aula*, ashlar is present at the arches of windows and gates or doors, also at the exterior corners, but not consequently. Several openings show inexactly fitting arch stones that could be reused. The *petit appareil* masonry is partially passed over by a hatchet or a large chisel and was originally covered by a *pietra rasa* plaster. This treatment included the big, round basement pillars. The small stones were easily to process and could be employed anywhere; this might have contributed to a quick construction process. Another reason for efficiency could have been a concise project, easy to

11 Historic copy of the so called “Eadwine Psalter,” Cambridge, Trinity College, Ms R 171 fol. 285 (after Benevolo 1983, 186, fig. 515, without signature; detail. Subsequent layout by the author.





**Fig. 8:** The “Double-hall-and-high” house (clockwise from top-left)

**A.** Cluny, houses 13, place Notre-Dame / 3, rue de la Barre. “Double-hall-and-high-house” from 1135/36 (d). Isometric reconstruction, view from North. Documentation Pl. 39, detail. Drawing: Bernhard Flüge

**B.** Cluny, houses 13, place Notre-Dame / 3, rue de la Barre, “Double-hall-and-high-house” from 1135/36 (d) Mediaeval West wall along the ascent of the Rue de la Barre: Frontal stairs forebuilding with biforium, central double hall volume, and four level high house in the back. Photo: Bernhard Flüge

**C.** Cluny, Place Notre-Dame, West porch of Notre-Dame (left), the square fountain in its Louis XVI state, and houses 11–13, place Notre-Dame (frontal view). Photo: Bernhard Flüge



mediate and to control. The identical dendrochronological dating results from the basement and from the roof indicate that the lumber was cut and prepared according to a preliminary calculation, and successively set in and adjusted during the erection of the building.<sup>12</sup> This

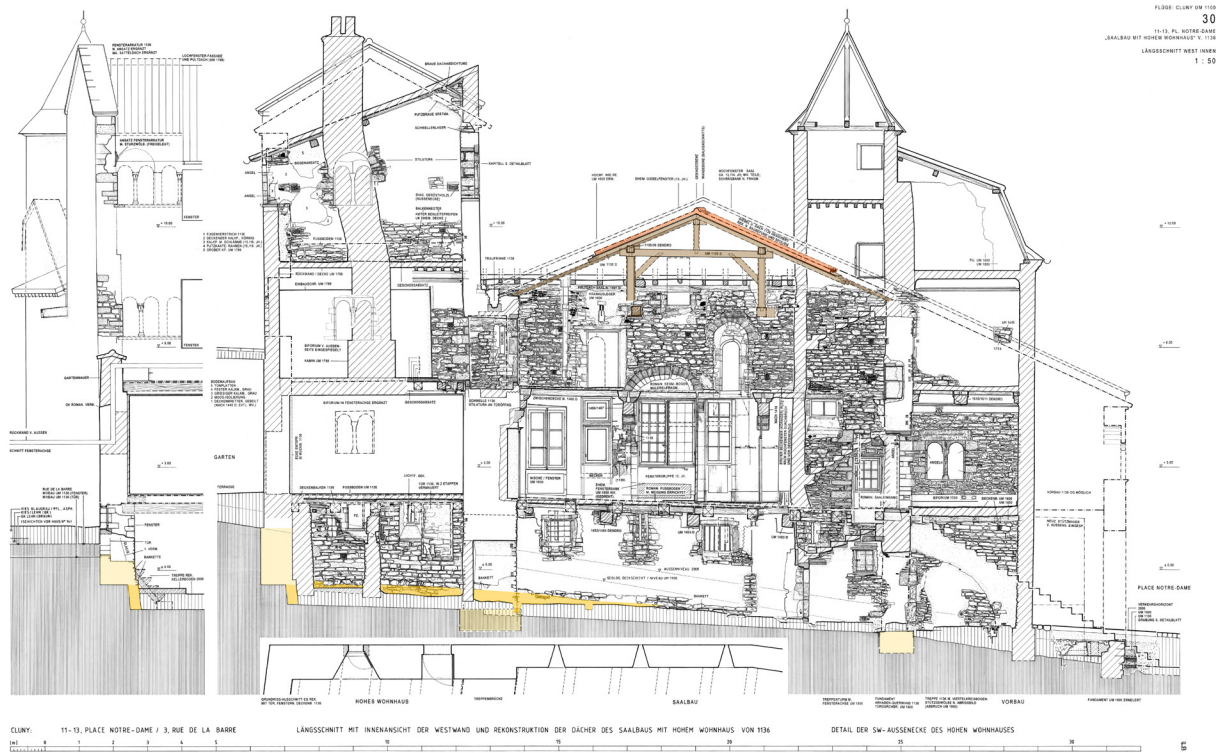
<sup>12</sup> Concerning this observation, the aula is not a case sui generis in Cluny. The house 23, rue Filaterie / 1, petite rue des Ravattes, which was equally documented by the author, was erected between A.D. 1193 and around 1205 (d); see Archéolabs N/réf. ARC05/R3325D. The timber of the basement ceiling was cut in the same year 1193 as the timber of the roof structure, including the center purlin and rafters, meanwhile only one of the roof’s trusses was composed of timber cut after 1200 during the erection of the roof and covered by “older” timber.



**Fig. 9:** Cluny, houses 13, place Notre-Dame / 3, rue de la Barre, "Double-hall-and-high-house" from 1135/36 (d).  
**A.** Basement level, arcades separating the hall volume from the high house. The deep arcades continue on the other side of the central wall (left) and support a system of mural stairs. Photo: Hans-Peter Vieser.  
**B.** Mural staircase between the 2nd and 3rd levels (hall volume on the left, high house on the right handside). Photo: Hans-Peter Vieser.



**Fig. 10:** Cluny, houses 13, place Notre-Dame / 3, rue de la Barre, "Double-hall-and-high-house" from 1135/36 (d). 4th level of the high house, North wall. **A.** Biforium, column with added base. Originally the windows disposed of wooden shutters instead of frames, that were fixed on the central column. Photo: Bernhard Flüge. **B.** Biforium (exterior), column base. Photo: Bernhard Flüge.



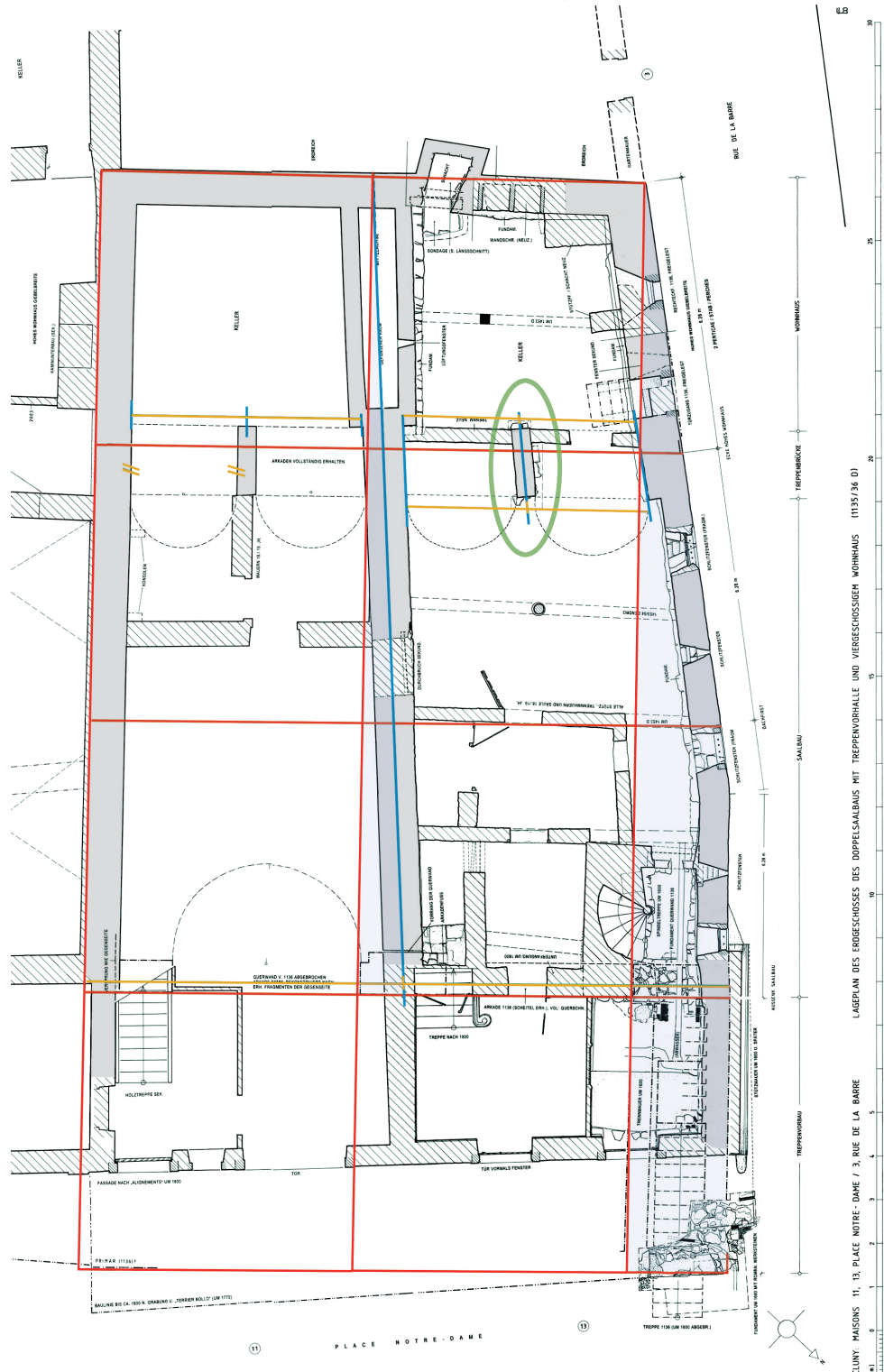
**Fig. 11:** Cluny, houses 13, place Notre-Dame / 3, rue de la Barre, “Double-hall-and-high-house” from 1135/36 (d). Longitudinal section with foundations realized in two steps (yellow; in dark yellow the excavation coat in single shell masonry) and roof structure, similar to Roman constructions. Documentation Pl. 30. Drawing: Bernhard Flüge.

circumstance implicates that the dating by dendrochronology of 1107/08 (d) indicates the beginning of the construction, not its completion, a fact that is of primary significance for monumental-archaeological interpretation. According to written evidence, the *Vita Hugonis* by Gilo, the abbot Hugo had the courage to begin the *aula* few before the end of his life—he died in 1109.<sup>13</sup>

There are also indicators for a preliminary dimension conception (Fig. 7). The transversal axis is shaped as it were the *cardo* of the building. This axis passes through the central gate<sup>14</sup> and cuts the round pillar in the centre of the ground plan. The pillar line corresponds to the longitudinal axis of the rectangular building. The centre-to-centre distance between the pillars is very constant around 6.32 m, which corresponds to the breadth of the house of 1091. The geometrical proportion of the plan of 4:1 corresponds to a structural rhythm of 8:2 and an arithmetical rhythm—in perches—of 16:4. The perch appears equally in the elevation: two times between the top edge of the foundations to the top edge of the hall floor; three times between the hall floor and the top edge of the console cornice. This basic dimen-

13 Gilo, *Vita sancti Hugonis abbatis* II, I, 90, “*aulam imperialem*” (Wollasch 1996, n. 261).

14 First discovered and documented by the author in 2006.



**Fig 12:** Cluny, houses 13, place Notre-Dame / 3, rue de la Barre, “Double-hall-and-high-house” from 1135/36 (d). Geometrical analysis of the ground plan. Red: Square grid of a highly probable conception delineation based on the unit of the double perch (6.30 m), analogue to method and length unit of the conception of the Aula from 1107/08 (d). Shaded: Discrepancies, consciously produced while pegging out the plan on the real terrain, due to the individual shape of the site. The longitudinal centerline of the grid is thus transformed into an exact angle bisector. Documentation Pl. 26. Drawing: Bernhard Flüge.

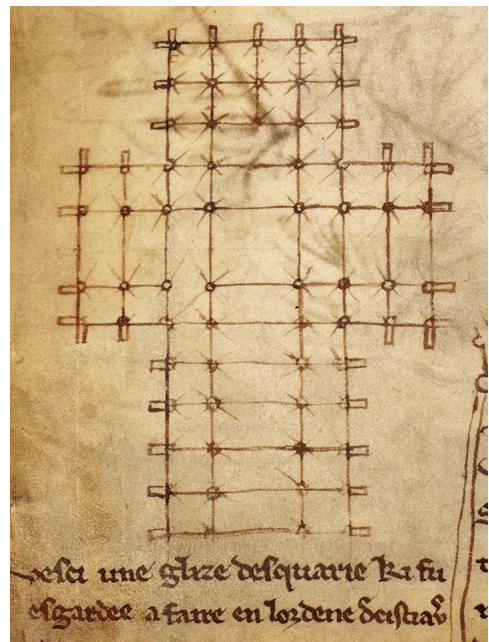
sioning of the building could have been fixed by a small linear rectangular grid design, easy to mediate and to transfer to the construction site.

The dimension of the walls seems to be defined by a frame contouring the grid, the exterior line of the frame corresponding to the contour of the building. Proceeding from this line, the basement walls were constructed 2 feet bigger than the frame width. The frame corresponds to the wall dimension of the main level. The basic dimensioning appears again within the total length of the roof construction and in the number of eight sills at the base of the roof. But the carpenters divided the total length of this specific truss-free construction into round 50 rafters, respectively 25 beam intervals—a parallel to the predominance of round distances within the building instructions of the *Liber tramitis aevi Odilonis abbatis*, a Cluniac source from the mid of the 11th century.<sup>15</sup> The technical solution of the end intervals in the carpentry, and the choice of big lumber sections, produced execution dimensions in multiple dependencies, that were adapted with a tolerance of about 2 inches into the pre-defined total length.<sup>16</sup>

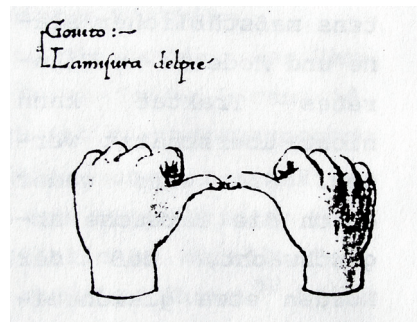
### The “Double-hall-and-high-house” from 1135/36 (d)

In the church square of Cluny stands a building from A.D. 1136 called by the author “Double-hall-and-high-house”. This is the second oldest dated town house in France, and also the largest of all so called Romanesque town houses in Cluny (Fig. 8). The exceptional type composed of two volumes, a lower hall and a higher dwelling house, originates from high nobility architecture and was in this example transferred into the growing mediaeval town. It is a house with a double hall on a basement, arranged left and right of a central wall. The frontal annex is covered in continuity with the hall roof. This connection of a hall and a frontal stairs annex on a common basement served as immediate prototype for the earliest of the well-known serial houses after 1150.

Between the hall structure and the 4-level dwelling house in the back, a sort of bridge construction on 4 arcades is inserted. In its interior, the circulation between the halls and the high house is organized in a minimized tube-like space, including the stairs to the third level of the high house (Fig. 9). A gutter covers this architectural part, draining the rainwater of the hall and the high house roofs to the lateral street. The gutter is composed of stones, the section of which is comparable to a Roman channel or gutter stone in the



**Fig. 13:** Villard de Honnecourt, *Livre de portraiture* (around 1220–1240). Linear square grid, characteristic of mediaeval building conception: “vesci une glize desquarie ki fu / esgardee a faire en lordene dcistiaus” – “See here an orthogonal[ly subdivided] church, that was envisaged to being made [built] in the order of Cîteaux”. The central and other lines of the preparatory grid design were originally 1986; 2003: 206. marks). B.n.F., Ms fr. 19093 fol. 14v. Transcription and translation by the author, 2015.



**Fig. 14: A.** Gilo, *Vita Hugonis, Foundation of the Abbey Cluny III*. Text and Illuminations of this page contain informations of high relevance for mediaeval conception history, based on distance units in an orthogonal alignment. The protagonist Gunzo shows in the right image the foot as the basic length unit of the conception of Cluny III. This act transforms the geometrical square cord grid of the left image into an arithmetical scale system. B.n.F., Ms lat. 17716 fol. 43r.

**B.** Filarete, *Libro di architettura* (ca. 1460), rule of thumb "La misura del pie." Firenze, BCNF, Fondo Nazionale ms II.I.140 (Codex Magliabechianus) fol. 4r. After Spencer 1965 (facsimile).

museum of Souvigny. A second parallel consists in the fact that both gutters were laid in brick meal mortar or *opus signinum*.

The main structure of the house from 1136 consists again of petit appareil masonry, covered by a *pietra rasa* plaster; ashlar appear in angles, arcades, doors and windows. Only the *biforia* columns feature sculptured ornaments; four examples have been preserved. These columns seem to be prefabricated. During the construction, at least one of the monolithic columns, all of them of approximately equal length originally, was retouched and extended by addition of a base element to obtain a higher window proportion (Fig. 10).

Several elements of a simple standing roof construction covering the hall section have been preserved; these permitted the positive reconstruction of five exactly parallel standing props orientated after the direction of the central wall, and the roof's conception seems to have been strictly aligned with the floor plan, the parallel transversal walls of the house

defining a constant width of all piers. Concerning the foundations, the house from 1136, in contrast to the house from 1091, already disposes of foundation trenches. But in lieu of a preliminary slope excavation for the whole construction, the common practice in modern constructions of comparable size, the excavations were realized in at least two steps. The foundation trench of the exterior wall does not reach down to the final basement level; that was obtained by digging up to three feet deeper in a second act (Fig. 11). The inner structures, like the arcade pillars and the central wall, were only founded on the final level, which retained a rest of the natural slope.

The parallel transversal walls divide the building length from front to back into four exact quarters, the first of which corresponding to the frontal annex, the two central ones to the halls volume, and the one on the back side to the high house. Every quarter corresponds to exactly two perches of 6.30 m length traced along the lateral street. The conception breadth of the building is contained in the garden façade of the high house and measures exactly four perches (12.60 m).

The trapezoidal enlargement of the building plan towards the front follows the topographic condition given by the lateral street and modifies a basic conception that consisted of a square grid of 4:2 double perches (Fig. 12). The middle axis of this square grid was realized as the angle bisector of the ground plan contour. The central wall was positioned exactly of this angle bisector, then the “bridge piles” exactly at the half distance between central and exterior walls. As a consequence, the western bridge pile (marked in green in fig. 12), positioned at its base on the angle bisector between the central and exterior walls, is orientated by a slight torsion of its rising structure in the direction of the transversal arcade. This kind of flexibility appears in many building details, where the orthogonal basic pattern is broken on account of the trapezoidal realization, particularly in door- and stairways. This building practice, based on distance tracing, avoids producing waste spaces and at the same time the basic conception remains perceptible.

### **Conception and building practices in residential architecture around A.D. 1100...**

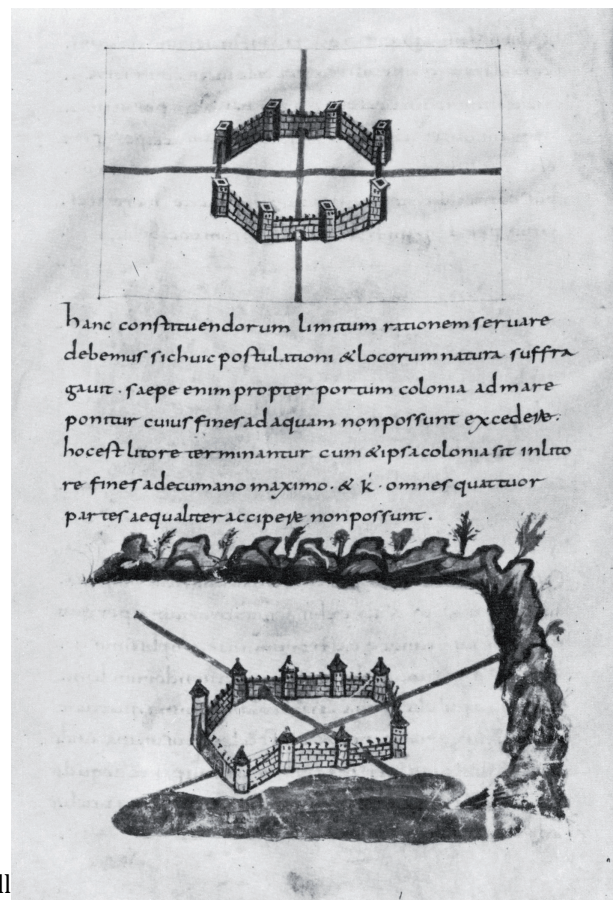
After this close look at three examples of still upright standing monuments, conclusions about building practices in residential buildings around A.D. 1100 in Cluny can be summarized as follows:

– The constructions are realized in a relatively simple but specific and flexible way. The omnipresent petit appareil masonry with *pietra rasa* plaster and the standing roof structures take up a building tradition going back to Roman times. The free standing two—or multiple—level *domus solarata* type buildings from 1091, 1108 and 1136 correspond to early medieval upper class house and palace models and are step-by-step transformed into an urban serial house type during the 12th century. The realized buildings have many economically and pragmatically motivated features. Corresponding dendrochronologic dating

results in basements and roofs indicate that the organization of the construction site follows a preliminary basic dimensioning and calculation.

– Basic dimensioning and building realization correspond to two discernible steps within the building process. Particularly for larger projects, the dimensions of ground plan and elevation could have been fixed in a small, linear, square grid design (cf. Fig. 13) and then transferred to the site. The geometry is rather simple, based on symmetry, the idea of the right angle, and distance measures. Structural dimensions were defined on the construction site, as well as the definitive position of walls. Discrepancies to the basic geometry are more motivated by topographic and pragmatic conditions than caused by error, and appear as parallelogram or trapezoid deformations of the rectangle. The arithmetic dimensioning system adopts an antique tradition, with perch, foot and yard in decimal or respectively duodecimal relation. There are no signs of a sophistic perfect number conception based on an absolute “Roman foot” of 29.5 cm, such as supposed for the Cluny III abbey buildings by several authors.<sup>17</sup>

The only mediaeval document providing information about building practices in Cluny around 1100 is the Latin manuscript 17 716 of the French National Library, in particular folium 43r with two remarkable illuminations. This source has been considered as a monument of Cluniac historiography (Fig. 14).<sup>18</sup> Meanwhile, its technical aspects have not been comprehensively explained to mediaeval studies so far. The possibility of a building historical interpretation has even been simply excluded, due to a missing approach.<sup>19</sup> After the preceding description of new-known exemplary buildings of the period and the place, a new interpretation of the technical aspects of the document is possible and even essential. The first illumination on the manuscript page fol. 43r illustrates a vision of an ancient abbot of Baume-les-Messieurs, the mother abbey of Cluny, named Gunzo, who lived his old age in Cluny. The vision instructs him about the construction of the new abbey church, the abbey church Cluny III. According to the text information, the cords stretched by the saints Peter, Paul and Stephen represent the mea-



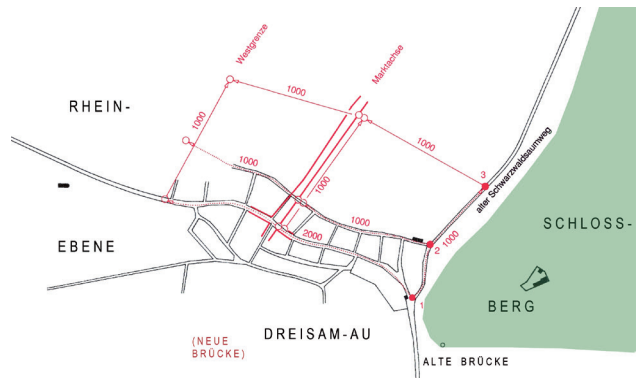
**Fig. 15:** *Corpus agrimensorum*. Geometric ideal (above) vs. a consciously “deformed” realization of a colonia, by respect of topographic conditions. B.A.V., Cod. Pal. Lat. 1564, c. 89v, 1st quarter 9th c. A.D. (after Guidoni 1981, p. 135, *Contes* 1968, Appendice B, 140–146, closely following the hypotheses of Alain Guerreau, particularly Guerreau 1998, 179–189.

18 Méhu 2002, 56.

19 Cf. Carty 1988, 113.



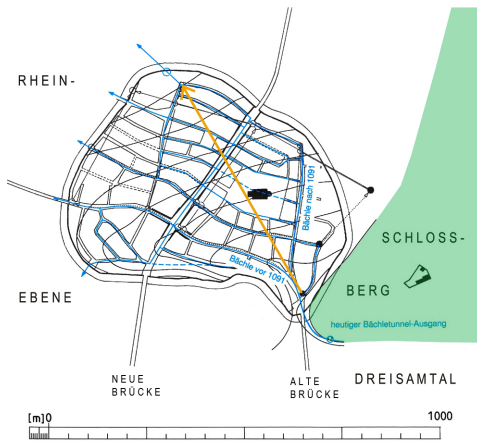
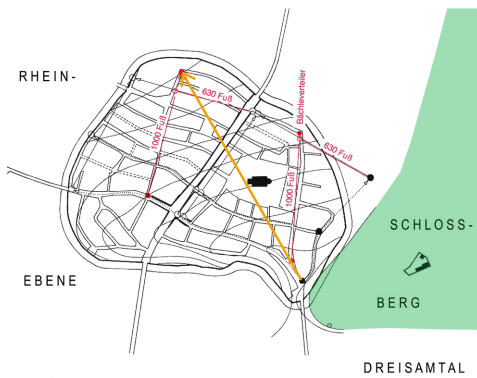
**Fig. 16:** Freiburg (Germany) (counter-clockwise from top-left).



**A.** Freiburg (Germany), proposition for the high mediaeval town conception around 1100, based on the coeval geometric systems and working methods discovered in Cluny. Documentation Pl. 6, detail. Drawing: Bernhard Flüge.

**B.** In Freiburg, the road and water run network was oriented after the drain direction of the terrain (yellow arrow). There are already late Antique centuriation examples showing this practice. Documentation Pl. 6, detail. Drawing: Bernhard Flüge.

**C.** Freiburg (Germany), water run ("Bächle"), most probably a structural element of the town foundation around 1100 A.D. Photo: Bernhard Flüge.



surement of the *quantitas* of length and breadth of the building—“*longitudinis atque latitudinis metiri quantitatem*”. The total dimension of the building is included within the two terms *quantitas* and *metiri*, as well as the aspect of the additive arrangement of the length unities. These distances define by their rectangular coordination as *longitudo atque latitudo* the grid of the architectural project; meanwhile the delimited surface itself is not mentioned. The painting translates the information of the document’s text immediately into the iconographic medium, and it identifies the building’ delimitation as a square grid. On the second image, Gunzo, who is now free of his confinement to bed, meets Abbot Hugo to mediate the

project instructions. His unusual gesture is conspicuous: this is not a rhetorical gesture, as Carolyn Carty proposes,<sup>20</sup> but technical information that completes the message. The gesture joins the breaths of the two hands to the length of the two stretched out thumbs, the thumbs touching each other at their heads. Exactly in this way the early Renaissance architect Antonio Averlino, called “il Filarete”, illustrates and describes the foot measure around A.D. 1460.<sup>21</sup> This rule of thumb represents the foot length definition already specified by Herodotus and mentioned by Gerbert d’Aurillac in the Middle Ages.<sup>22</sup>

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20 Ibid.

21 Cf. Filarete, *Libro di architettura* (ca. 1465), Cod. Magliabechianus, Liber I fol. 4v: “[...] Unaltra misura ancora chiamata pie laquale pocho susa pure in alcuno luogho susa & questo pie e dimisura didue mani strette / o vuoi dire raccolte lequattro dita el quinto disteso & agiugnierlo dipunta luno alaltro questo sidice essere un pie [...]”; illustration “la misura del pie” on fol. 4r. (Cod. Magl., Liber I. Firenze, BCNF, Fondo Nazionale ms II.I.140. [Spencer 1965, II (facsimile)].

22 Gerbert, *De disciplinis mathematicis: Geometria II*; Pl. 139, 96–98 (after Naredi-Rainer 1982, 105, n. 138).

This fixed unit of length delimits the building and makes its dimensions rationally comparable. It characterizes the rectangular cord grid of the central image as an arithmetic scale system. Beyond this, it is easily imaginable, that Gunzo makes use of his gesture to express visibly the length of one perch or a multiple of it. He would demonstrate a rational scale relation between a small preliminary visualisation and the real-size construction. In this way, the conception of the *aula imperialis*, for example, could be presented in a few minutes. And there is another text aspect to remark: "*Nec de sumptibus dissidat*"—the abbot is obliged not to be repugnant to the construction costs. The document limits its information related to the Cluny III project strictly to the high priority questions of any important decision in the building sector: demand analysis, dimensioning, costs, and project management. All this indicates a real background of the story that uses the vision of saints as *pia fraus* to promote a giant and expensive building project.

### **...inherited from Roman Antiquity**

Looking for instruction placed at the disposal of master builders, masons, and geometers around 1100 AD, there existed, besides a partial translation of Euclid, only the treatises of the *gromatici* or *agrimensores*, called *Corpus agrimensorum*. The area of eastern France/Upper Rhine was at that time a centre of circulation of this compendium.<sup>23</sup> The Benedictine abbeys like Cluny accomplished the document tradition and transcription. Indeed, all units of measure and related systems, as well as the square grid idea, observed in the mediaeval buildings, are part of the content of the *Corpus agrimensorum*.<sup>24</sup> The large scaled orthogonal coordinate system, by which the modern eye identifies the *agrimensores*, was not applied in the High Middle Ages. Instead, another important instruction: By word and image, the *agrimensores* oppose an imaginary ideal geometry to the recommended realization, shaped after the nature of the locality in question with existing structures (Fig. 15). The discrepancies between a geometrical ideal and the reality observed in mediaeval buildings appear also on the urban level, with the same characteristic graphic patterns. The recognition of the topography as an important factor in mediaeval building practices, together with the repartition of dated edifices, leads to completely new reconstructions. In Cluny, an approximately rectangular street network completes two older, curved Gallo-Roman roads. The hitherto accepted polycentric town evolution of Cluny had to be revised in favour of one single nucleus. Simple and logic answers were found for concrete problems, e.g., why the main gate of the abbey is situated so strangely aside at half height.<sup>25</sup> The respect of the topography in mediaeval planning and space organization, proposed by the *Corpus agrimensorum*, seems to be a general phenomenon of the period: In Freiburg im Breisgau, the oldest known mediaeval town foundation in Germany, the town perimeter and streets going back to the foundation period show the same geometrical characteristics as the building plans analysed in Cluny. They were laid out after

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23 Cf. Reeve 1986, 1–6.

24 Cf. Blume/Lachmann/Rudorff 1852, 355.

25 For elaboration and discussion of these and the following topics, see Flüge forthcoming, chapter VI (cf. n. 1 of the present article).

the topo-geographic conditions in three steps: first the town's main axis, the *cardo*, parallel to an older long distance path accompanying the foot of a Black Forest mountain from south to north, then the town perimeter approaching a square contour around the main axis—with deformations due to geographical relief and existing structures such as a few roads and buildings, and thirdly the new part of the road system, strictly oriented after the drain direction of the terrain (Fig. 16).<sup>26</sup> There exist already late Roman examples of the orientation of a geodetic grid after the drain direction.<sup>27</sup> The famous water runs of Freiburg have commonly been dated into the years around 1170 after a series and concatenation of erroneous interpretations of the accumulated archaeological street levels, beginning in Gauchstrasse, by the local mediaeval archaeologists. The channel network can now be explicated in a new way as an element and even, with the utmost probability, a condition of the original plan around 1100.<sup>28</sup>

Within high mediaeval town realizations, constitutional elements of the Roman space organisation are preserved: as central institutions the *crux viarum* (the High Cross) and the *forum* (market). The new observations establish that high mediaeval building and urban conception and realization practices are in essential aspects closer connected to Roman Antiquity than the idealized post mediaeval ones.<sup>29</sup>

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26 The Bertolds, later named Zähringer, Dukes of the Veronese Mark and Earls of Breisgau, were closely bound to the Cluny Abbey. Her(i)mann(us) I., the brother of the founder of Freiburg, Bertold II, was initially himself Earl of Breisgau and Earl of the Veronese Mark, and he became later monk in Cluny, where he died in 1074 (cf. Parlow 1999, XXVIII. The celebrated abbot Hugues de Semur (1049–1109 wrote a vita of Her(i)mann(us)).

27 Antique centuriation according to the draining direction existed e.g. near Padua, at the via Postumia (*decumanus*) and the state road Padua-Bassano (*cardo*), as well as along the channel Carrara-Bovolenta-Pontelongo; cf. Galsterer 1992, 418.

28 Cf. Flüge forthcoming, Kap. VII.3.1.c.

29 L.c., Kap. VII.3.2.

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