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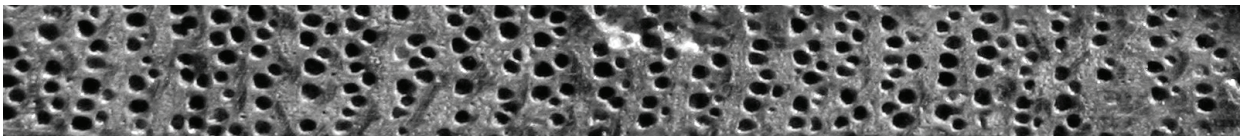
# REPORT OF DENDROCHRONOLOGICAL ANALYSIS

**Dr Pascale FRAITURE**

# Central panels of the *Ghent Altarpiece*

## Hubert and Jan van Eyck

Ghent, St Bavo Cathedral



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# Table of contents

## 1. Study purpose

This report presents the analytical process and results of the dendrochronological study carried out on several panels of the *Adoration of the Mystic Lamb* by Hubert and Jan van Eyck.

The present analysis was undertaken as part of an international project for research and conservation of the *Mystic Lamb* initiated by the council of St Bavo Cathedral. This project began in April 2010 with the aim of determining whether a more complete restoration was needed in the short-term. It involves several institutions, including the Royal Institute for Cultural Heritage, which was entrusted with, among other tasks, the dendrochronological examination of the central panels of the altarpiece: *God the Father,* the *Virgin Mary* and *Saint John* for the upper part and the *Adoration of the Lamb* for the lower. This study complements the first dendrochronological campaign undertaken by IRPA/KIK in 1986[1].

The scientific analysis was financed by the Getty Foundation (Getty Grant Program, Panel Paintings Initiative) and coordinated by Ron Spronk (Queen's University, Canada).

## 2. Description of the panels studied[2]

The three panels of the upper section, *God the Father*, the *Virgin Mary* and *Saint John*, are each composed of three oak planks (*Quercus* sp.) with widths varying between 20.2 and 32.7 cm and lengths of 168-168.6 cm for the *Virgin Mary* and *Saint John* and 212.5 cm for *God the Father*. The support for the *Adoration of the Lamb* is itself formed of four planks with widths between 32.2 and 36.8 cm and a length of more than 243.3 cm (Fig. 1).

For each panel, the external planks were assembled following a logic of solidity that advocates the avoidance of placing the edge of the sapwood[3] (Fig. 2), which is softer, as the external edge of the panel (Fig. 1, arrows indicate the direction of ring growth, from the pith toward the sapwood).

The four supports analyzed by dendrochronology include 13 oak elements. The orientation of plank cutting in the log informs on the care taken during wood preparation since a radial cut provides the best quality planks, minimising the risks of wood shrinkage during changing environmental conditions. In radial cutting, *full quarter* (or *full radial*) cutting, which represents a perfectly radial cut that precisely follows the medullary rays of the oak, is distinguished from *quarter* (*radial*) cutting, which is slightly offset from the medullary rays (the offset must be less than 45°; more than this and the type is termed semi-radial, Fig. 2). It should be pointed out that the orientation of plank cutting was determined for both edges of each plank, since they are not systematically identical: differences between one edge and the other reflect minor deviations in the grain of the trunk. Of the central panels of the altarpiece, four planks were cut on full quarter (Fig. 10, 12, 13 and 14) and the remaining nine planks have one edge on full quarter and the other on quarter (Fig. 3 to 9, 11 and 15; Tab. 10.2). These variations in wood grain are not exceptional given the length of the planks. The observation of the medullary rays reveals, in contrast, that the majority of the planks were obtained from oaks for which growth was more or less twisted: on most of them, the rays are curved, or even sinuous, rather than rectilinear (Fig. 3 to 15; Tab. 10.2).

[1] VYNCKIER J., 1999-2000. We add that we have also attempted an examination of the wing panels of *Adam* and *Eve*, only on the zones of the edges accessible without removal of the frame. However, the bending of the panels prevented precise recording of ring sequences sufficiently long to obtain a reliable date (dossiers dendro. no. P452 and P455). These two wings were also analyzed by P. Klein (Universität Hamburg), using X-rays undertaken at IRPA/KIK in 1986. See KLEIN P., *Report on the dendrochronological analysis of the panels "Adam and Eve" (Jan van Eyck)*, Universität Hamburg, 17-11-2010, 1 p. Moreover, we benefited from the arrival of the *Just Judges* panel at IRPA/KIK in June 2010 to record the edges with digital macro-photographs for possible future dendrochronological analysis (dossier dendro. no. P451).

[2] See Table 10.2 which groups the observations detailed in this chapter.

[3] *Sapwood* is the peripheral part of the trunk – it contains the most recent rings in the life of the tree – through which the raw sap rises from the roots to the branches; it is thus rich in nutritional substances and very easily degradable (Fig. 2).

The growth rate corresponds to the average amount of wood produced per year. Slow growth is characterised by narrow rings (Fig. 3c), rapid growth by wide rings (Fig. 10c). Calculation of the mean width of the rings thus reflects the average growth rate of an individual tree[4]. Trees with slow growth produce softer wood that is relatively impervious to deformation due to shrinkage or dilation; they are thus suitable to make stable supports for paintings. Identification of the growth rate for the different planks studied reveals homogeneity within the panels. Most of the planks (8 of 13) show slow to very slow growth, the mean ring width being less than 1.2 mm; the growth rate of four other planks can be considered medium: relatively rapid at the beginning of the sequence and then slowing; finally, one element shows rapid growth, the mean ring width more than 2 mm (Fig. 3c to 15c; Tab. 10.2). It should be pointed out that the growth rate is generally more rapid at the beginning of a sequence and progressively slows as the tree ages. For the planks with very slow growth, it was already slow at the beginning of the sequence and slowed even further, giving sequences of rings that are nearly indistinguishable (Fig. 9c).

The pith and the sapwood are parts of the wood unsuitable for making quality supports since they are susceptible to deformation and/or rot. It is thus recommended that craftsmen remove these parts. While pith is almost never present, two planks have some sapwood remaining: the left plank of *Saint John* and the left plank of the *Virgin Mary*. For the *Saint John* plank, it had been in large part replaced by healthy wood (Fig. 10c)[5]; for the *Virgin Mary* plank, the sapwood is quite visible on the back due to its light colour (Fig. 13d). Despite the presence of these sapwood fragments, the first and last growth rings of the trees were removed from all of the planks.

Planks with such characteristics were obtained from remarkable oaks. Indeed, to produce such wide elements (more than 30 cm for the most part) from slow-growing trees, oaks several centuries old have been used: some of the dendrochronological sequences number more than 350 rings, without the first and last growth rings; some of the trees used for the panels of the *Mystic Lamb* would have been 400 years old!

## 3. Preparation of the sequences and measurement recording

During the dendrochronological analysis of a work of art, as opposed to the studies of buildings or archaeological materials, the dendrochronologist does not remove a sample, given the precious nature of the object: direct access to the rings is necessary. These can be measured on the *end grain*, that is, on the surface of the transversal section of the tree (Fig. 2). For the supports of the upper section of the altarpiece, *God the Father*, *Saint John* and the *Virgin Mary*, it is the horizontal edges of the planks that meet this condition, the grain of the wood being vertical; for the *Adoration of the Lamb*, it is the lateral edges, the grain being horizontal (Fig. 1).

Several techniques for acquiring dendrochronological data are available, of which the most commonly applied is the recording of the ring thicknesses directly on the piece, using a magnifying glass or microscope. For several years, we have developed an indirect measurement technique: recording of the ring series on digital macro-photographs calibrated on a semi-millimetric scale (Fig. 3c to 15c)[6]. This process was made possible by the development of computer software for measuring the thicknesses of the rings directly on the computer screen[7]. The advantage of this new method is to provide the dendrochronologist with recordings of the rings which can be referred to at will, for verification during measurement, for example, or for future re-evaluations.

[4] A mean ring width of around 1 mm represents very slow growth, while a mean ring width greater than 2 mm reflects rapid growth (FRAITURE 2007).
[5] The location of the sapwood marks the place broken during the 1978 accident: the wood was worm-eaten and had weakened the support (IRPA/KIK archives).
[6] FRAITURE 2007; 2009.
[7] Data recording and the *Dendron II* program are due to G.-N. Lambert, Centre National de la Recherche Scientifique – Laboratoire de Chrono-Écologie de l'Université de Franche-Comté (UMR 6249). LAMBERT 2006.

Before taking the photographs, preparation of the wood is often necessary in order to make the separation between the rings clear. In the present study, several techniques were applied, depending on the degree of cleaning needed. The softest consisted in simple brushing of the plank edges; this process sufficed on the cleanest edges and/or when growth was not too slow (Fig. 3c, 6c, 10c, 14c et 15c). In other cases, refreshing using "Stanley cutter" blades, flexible and very sharp, was required, in particular for less regular sections and/or for very narrow rings; this was generally partial and done along with brushing (Fig. 7c, 8c, 9c, 11c, 12c, 13c)[8]. Finally, the prototype for the laser apparatus developed at the University of Liège (ULg/CEA) in the framework of my university research, was used in places on the support for the *Adoration of the Lamb*, here again along with brushing (Fig. 4c et 5c). This system enables a very superficial cleaning without abrasive chemical or mechanical action[9].

In general, the opposing edges of planks (the two *radii*) are analyzed, in order to locate any growth anomalies in the oak, to correct deficiencies due to damaged sections in the wood (nail holes, insect networks, etc.) and to indentify the most recent ring in the series. This approach was adopted only for two elements[10]. In the others, the irregular surface of the wood would have required the preparation of dendrochronological measurement paths that would have been too invasive (Fig. 4b and 9b). In the present study, the large number of planks available compensates for the advantages that double measurement per plank offers.

The photographs taken on the edges of the planks are uploaded to the computer, the ring sequences measured onscreen in the laboratory (precision 0.01 mm) and processed using specific software[11].

Recording the ring thicknesses proved difficult on several planks, mainly because of the narrowness of the rings, difficult to differentiate (Fig. 4c and 9c), growth distortions[12] and minor deterioration of the wood that interrupts the dendrochronological series (Fig. 8c and 12c). However, cutting is radial and the planks are thick (0.9-1.5 cm on the edges of panels in the upper section, and 1-1.7 cm for the lower section), which makes it possible to bypass these difficulties. In the end, at least one reliable dendrochronological sequence was recorded for each plank.

## 4. Data processing by computer

A well-established collaboration between European dendrochronologists (G.-N. Lambert, Besançon; I. Tyers, Sheffield; P. Hoffsummer, Liège; W. Tegel, Bohlingen; C. Perrault, Besançon; E. Jansma, Amersfoort; S. Wrobel, Hamburg and P. Fraiture, Brussels) ensures a constant exchange of databases between the different laboratories.

The *Dendron II* program, developed and regularly updated by G.-N. Lambert[13], ensures the organisation of these databases in which dendrochronological sequences can easily be compared and grouped in the form of regularly refined and updated repositories.

[8] The only edges that were prepared with a cutter from end to end are the upper edges of two planks from *Saint John*, which are not the original edges: the panel would have been slightly shortened, indicated by traces of framing and minor traces of sawing (Fig. 10b).
[9] The creation of the system was made possible by subsidies granted by the *Fonds de la Recherche Fondamentale Collective* (*Fonds National de la Recherche Scientifique*) and the *Fonds spéciaux pour la recherche de l'Université de Liège*. Development of the technical characteristics of the laser was done by *Laséa* (Brevet BE 9900367). FRAITURE 2009.
[10] Left plank of *Saint John* (Fig. 10) and third plank from the bottom of the *Adoration of the Lamb* (Fig. 5).
[11] LAMBERT 2006.
[12] *Distortions* are deformations of the rings characterised by offsetting of the vessels from one side of a medullary ray to the other.
[13] LAMBERT 2006.

## 5. Dendrochronological dating

The dendrochronological sequences recorded on the 13 elements were compared, initially to verify the accuracy of the measurements and potentially to recombine them when they were measured in several segments (see point 3). In addition, such comparisons serve to determine whether certain planks come from the same oak.

From a methodological viewpoint, there is no established approach that enables confirmation that planks come from the same tree; it is on the basis of different criteria that the dendrochronologist reaches a conclusion[14]. In practice, the strong similarity between dendrochronological graphs of ring series and high correlation rates in dendrochronological tests provide convincing arguments. Added to these is the comparison of mean ring width and the contemporaneity of the sequences compared, which reflects the tree's growth: the growth rate and the age of the tree[15]. Finally, observation of the wood itself may contribute some of the answer, for example, when a growth irregularity is seen on two different planks.

Consideration of all of these criteria for the planks of the altarpiece studied during this campaign identifies that the central plank and the right plank of the support of *God the Father* came from the same tree (Fig. 1: planks P463/02 and P463/03). The similarity between the graphs is striking (Tab. 11.7.2); the mean ring widths are similar (Tab. 10.2)[16]; the structure itself of the wood is perfectly comparable (Fig. 8 and 9) and the sequences have nearly contemporaneous ring series (at least for the ends of the sequences, Tab. 10.1)[17].

Likewise, this type of comparisons between the left plank of the same panel (P463/01) and one of the planks of the *Adoration* (the second from the bottom, P466/02) leads us to the conclusion that these planks also came from a single tree (Tab.10.1, 10.2, 11.7.2 ; Fig. 4 et 7)[18].

It should be added that these two pairs of planks also show strong resemblances between them. However, the quality of these different criteria for comparison do not reach the level met between planks P463/02 and P463/03 on one hand, and between P463/01 and P466/02 on the other (Tab. 11.7.1). These two pairs of planks have similar characteristics, indicating that they came from two trees that grew under similar conditions (neighbouring trees in the same forest?).

The 13 planks analyzed thus would come from 11 distinct oaks. The dendrochronological sequences derived from a single tree (the two measurements on a single plank or measurements from different planks from the same tree) have been combined in their contemporaneous position (*synchronisation*) to calculate the dendrochronological mean representative for each oak. The composition of these 11 sequences or dendrochronological means is summarised in the table below; it is these means that are compared to our chronologies reference database in order to date them[19].

[14] FRAITURE 2007, BEUTING, 2004.
[15] These two criteria nevertheless suffer from imprecision since, even within a single oak, they can vary depending on the location of the sample in the trunk. Moreover, the number of rings in a sample, while it gives an idea of the age of the tree, also depends on the work involved in preparation of the wood.
[16] The start of the right plank (P463/03) was not measured due to the presence of an encrusted piece, which explains the slight different in mean rings (1.05 mm for this and 1.11 mm for P463/02): the absence of the first rings, which are wider, reduces the mean for this plank.
[17] The fact that one of the planks was not entirely measured explains the difference in sequence length and, from this, the dating for the first rings. As for the very minor difference in date for the final rings (1357 for P463/03and 1368 for P463/02), a loss of 0.6 cm of wood during squaring of the plank P463/03 would suffice to fill this interval.
[18] The left plank of the panel of *God the Father* is much narrower than the plank for the *Adoration* from the same tree (20.2 cm versus 34.8 cm, Fig. 1). This difference alone explains the difference in the length of the sequences compared (in particular from the side with the first rings) and the slight difference between the mean rings (see note 16).
[19] Comparisons between the sequences to be dated and the reference database were done using the *Dendron II* program (LAMBERT 2006).

| Name of the dendrochronological sequence to be dated | Dendrochronological components included in the means | Location of plank edges |
|---|---|---|
| **P463-02-03-ech** | - P463/02/1<br>- P463/03/1 | - Lower side of the central plank of *God the Father*<br>- Lower side of the right plank of *God the Father* |
| **P463-01-P466-02-ech** | - P463/01/1<br>- P466/02/1 | - Lower side of the left plank of *God the Father*<br>- Left side of the 2nd plank from the bottom of the *Adoration of the Lamb* |
| **P464-01-ech** | - P464/01/1<br>- P464/01/2 | - Lower side of the left plank of *Saint John*<br>- Upper side of the left plank of *Saint John* |
| **P464/02/2ab** | - P464/02/2a<br>- P464/02/2b | - Upper side of the central plank of *Saint John*, measured in two segments |
| **P464/03/2** | / | - Upper side of the right plank of *Saint John* |
| **P465/01/1** | / | - Upper side of the left plank of the *Virgin Mary* |
| **P465/02/1** | / | - Lower side of the central plank of the *Virgin Mary* |
| **P465/03/1b** | / | - Lower side of the right plank of the *Virgin Mary* (without the beginning of the sequence) |
| **P466/01/1** | / | - Left side of the bottom plank of the *Adoration of the Lamb* |
| **P466-03-ech** | - P466/03/1<br>- P466/03/2 | - Left side of the 3rd plank from the bottom of the *Adoration of the Lamb*<br>- Right side of the 3rd plank from the bottom of the *Adoration of the Lamb* |
| **P466/04/1** | / | - Left side of the top plank of the *Adoration of the Lamb* |

The IRPA/KIK reference database includes three classes of data. First, *master chronologies* or *regional chronologies* that have been constructed by different European laboratories; these are long dendrochronological sequences combining hundreds, sometimes thousands of wood samples, covering several centuries and each representative of a more or less extensive geographic area. Second, *site chronologies*, also produced by different laboratories; these group contemporaneous woods coming from a single building or archaeological site. Third, *individual chronologies* obtained from panel paintings of the Southern Netherlands, meaning dendrochronological sequences each representative of a single tree; these were constructed by J. Vynckier (formerly of IRPA/KIK) and P. Fraiture (IRPA/KIK, formerly ULg/CEA). The determination of the exact position of a sequence to be dated on these reference chronologies dates absolutely the year of formation of each ring and, by extension, the period during which the tree lived.

Eight chronologies for the central panels of the altarpiece provide indisputable results, through comparison with the different classes of data in the reference database: regional, local and individual (Tab. 11.2 to 11.5). The following table summarises these dates.

| Dendrochronological sequence | Length of the measured sequence (number of rings) | Date of the first ring measured | Date of the first sapwood ring | Date of the last ring measured |
|---|---|---|---|---|
| **P463-02-03-ech** | 296 | 1073 | / | **1368** |
| **P463-01-P466-02-ech** | 354 | 1036 | / | **1389** |
| **P464/03/2** | 151 | 1250 | / | **1400** |
| **P465/02/1** | 151 | 1258 | / | **1408** |
| **P465/03/1b** | 168 | 1233 | / | **1400** |
| **P466/01/1** | 233 | 1147 | / | **1379** |
| **P466-03-ech** | 357 | 1036 | / | **1389** |
| **P466/04/1** | 227 | 1173 | / | **1399** |

These positions are identified by chronologies originating around the Baltic Sea. This indicates that the oaks used in the central panels of the altarpiece came from this vast geographic zone. The origin of such imported woods is as yet imprecise; it appears, however, that several different zones were exploited over the course of time, going from northern Poland probably to modern Russia[20]. Many historical sources attest to considerable exportation of north-eastern oaks to the Low Countries starting in the 14th century, via the Baltic ports[21]. Dendrochronology contributes to the understanding of this activity since most of the supports used, among others, by Flemish painters from the 14th to the middle of the 17th century, were made with this kind of wood[22]. Available in great quantity, it had mechanical properties especially suitable to obtain quality planks[23].

Two additional sequences of the altarpiece were dated principally by other planks of the same ensemble analysed by J. Vynckier[24] (Tab. 11.2.5 & .6, 11.3, 11.4 et 11.5.5 & .6). These comparisons have also highlighted the relationship between the left plank of the *Virgin Mary* (P465/01/1) and a plank from the panel of the *Angels Playing Music* and its pendant on the *Virgin* in *grisaille*[25]: the similarity between the graphs and the quality of statistical tests indicate that they come from the same tree (Tab. 11.2.6 and 11.5.6). The following table summarises these two supplementary dates.

| Dendrochronological sequence | Length of the measured sequence (number of rings) | Date of the first ring measured | Date of the first sapwood ring | Date of the last ring measured |
|---|---|---|---|---|
| **P464/02/2ab** | 197 | 1207 | / | **1403** |
| **P465/01/1** | 203 | 1204 | 1398 | **1406** |

Finally, the last sequence, the left plank of *Saint John* (P464-01-ech) also yielded a date (Tab. 11.2.3, 11.3.3, 11.4.3 and 11.5.3). This plank was quite different in character from the others. For example, its mean growth is more than 2 mm (Fig. 10) and it is the only plank to show more similarities with the *BALTIC2* reference chronology[26] (Tab. 11.2.3 and 11.5.3) while all of the others analyzed are closer to *BALTIC0*[27]. These master chronologies characterise distinct dendrochronological typologies that would reflect changes in source of wood procurement[28]. The *BALTIC2* typology is rarely encountered for woods of this period, which explains the difficulties in the dating of P464-01-ech since, as a result, few samples of *BALTIC2* type woods are included in the reference database for this period[29].

| Dendrochronological sequence | Length of the measured sequence (number of rings) | Date of the first ring measured | Date of the first sapwood ring | Date of the last ring measured |
|---|---|---|---|---|
| **P464-01-ech** | 96 | 1317 | 1407 | **1412** |

[20] Studies are in progress in different European laboratories to attempt to clarify these provenances. For a review of this issue, see for example Eckstein & Wrobel 2007 and Fraiture 2009.
[21] See, for example, Baillie 1984; Tossavainen 1994; Zunde 1998-99.
[22] Regarding the discovery of the use of "Baltic" wood by dendrochronology, see Baillie, Hillam & Briffa 1985 and Eckstein, Wazny, Bauch & Klein 1986. For the use of Baltic oak in Flemish works of art, see, for example, Fraiture 2009.
[23] The rigorous climate of these regions gives rise to slow-growing trees, producing softer wood unsusceptible to deformation. Moreover, competition between individuals in these dense forests generates a rectilinear growth of the oaks, an appreciable quality for the production of long planks.
[24] Vynckier 1999-2000.
[25] Recall that the wing panels were sawn across their thickness to separate them into two panels; each plank has thus provided two series of data: here these involve planks XVI-A and VI-C following the schema in Vynckier 1999-2000, p. 238.
[26] Hillam & Tyers 1995.
[27] Tyers, unpublished.
[28] Hillam & Tyers 1995, Fraiture 2009.
[29] Hillam & Tyers 1995, Fraiture 2009.

In sum, the 13 planks of the central panels, coming from 11 different trees, have been successfully dated. The comparisons between all of the planks of the altarpiece dated by IRPA/KIK[30] reveal a homogeneous group from a dendrochronological viewpoint, since most planks have good correlations with the other planks (Tab. 11.6.1 and 11.6.2). This homogeneity can be interpreted as being a sign of a similar provenance for the oaks, although this degree of "proximity" remains relative in zones where climatic conditions and soils are the same for hundreds of km$^2$.[31] Two planks can be distinguished in the group: P464-01-ech (left plank of *Saint John*) and, to a lesser degree, P465/02/1 (central plank of the *Virgin Mary*; Tab. 11.6.1). The case of P464-01-ech is easily explained by its growth profile, which is quite different from the others (see above). As for P465/02/1, the relative weakness of synchronisms in comparison with the other planks can be explained a variety of ways, whether due to a less strong climatic signal[32], or that it is different[33].

## 6. Interpretation of the results

The chronological information obtained from the study of growth rings refers to the felling period of the trees. This is determined to the exact year if the cambium[34], and thus the complete sapwood, is preserved on the wood analyzed (Fig. 2-A); this condition is rarely encountered when studying panel paintings.

If part of the sapwood is present, the heartwood[35] is thus entirely present, and only some of the sapwood rings will have been removed (Fig. 2-B). A statistical study of oaks from northern Poland has shown that these oaks contain between 9 and 36 sapwood rings[36]. This statistical range is currently considered the best adapted to the "Baltic" oaks used in paintings because at present it concerns the geographic zone studied assumed to be the closest to that for these woods[37]. Minimal and maximal values for the number of sapwood rings thus enable situating the felling of a tree within a range of dates[38].

When no sapwood is preserved, it is impossible to determine the amount of heartwood removed during plank manufacture (Fig. 2-C or D) and, as a result, how many years separate the date of formation of the last ring measured from the real date of tree felling. The dendrochronological result then corresponds to a date after which the tree could have been cut down. To this result can be added a number equivalent to the minimum number of sapwood rings (9 rings according to the estimation method selected) to give the earliest year from which the tree could have been felled; this is termed the *terminus post quem* for the felling[39].

After determination of the felling period, the time interval between cutting down the tree in the forest and completion of the painting must be taken into account. This includes squaring the trunk, cutting it into quarters, floating to the ports, transport by sea to distribution centres, another phase of cutting the wood into planks, drying (which may be fairly quick), possible storage in the different warehouses or workshops (wood merchants, panel makers, painting workshop) and the manufacture of the support itself.

[30] Those analysed by J. Vynckier in 1986 and those studied in the present campaign.
[31] These similar conditions induce a dendrochronological signal that can be common to oak populations in these very vast zones (WAZNY & ECKSTEIN 1991).
[32] Stronger influence of genetic factors of the tree, more favourable environmental context (which would also explain the slightly more rapid growth of this tree in relation to the others of the group)… These factors blur the climatic signal.
[33] Slightly different provenances, and slightly different growth conditions (altitude, etc.).
[34] The *cambium* is the source of reproductive cells that form the sapwood toward the inner trunk. It is found on the periphery of the trunk between the sapwood and the bark.
[35] The *heartwood* is the biologically inactive part of the wood. A ring is formed in the sapwood; after a few years, it is transformed into heartwood.
[36] ECKSTEIN, WAZNY, BAUCH & KLEIN 1986.
[37] Other studies are, however, in progress on living oaks in the Baltic countries; these should help to refine or adapt the sapwood intervals to apply (Ian Tyers, Dendrochronological Consultancy Ltd, Sheffield, pers. comm., 14/03/2011). It should also be noted that there are different methods for sapwood estimation (see, for example, HILLAM, MORGAN & TYERS 1987).
[38] This range will be more or less restricted by the number of preserved sapwood rings and the number of woods which still have sapwood present.
[39] Keeping in mind that the estimation range for sapwood rings will be adjusted by new statistical analyses.

Systematic estimation of the interval between the dendrochronological result and the date of use, in order to better identify the period for artistic execution, is an unrealisable ideal, given the number and variability in the parameters affecting this length of time, even for works within a given period[40] and a given format, and even in the favourable case in which some of the sapwood is still present[41]. It is for these reasons that the interpretation of the results of dendrochronological dating of the altarpiece is presented in the form of a *terminus post quem* date as an estimation of the date of support manufacture, corresponding to the year from which the trees could have been felled (Tab. 10.1 and 11.6.3).

## *6.1. Lower section of the altarpiece*

The table below lists the dates and felling estimations for the different trees used to make the planks of the panel of the *Adoration of the Lamb*.

| Dendrochronological sequence | Plank | Last ring measured | Sapwood | Felling estimation |
|---|---|---|---|---|
| P466/01/1 | Bottom (from the front) | 1379 | / | *Terminus post quem* 1388 (1379 + 9) |
| P463-01-P466-02-ech | 2nd from the bottom (with left plank from *God the Father*) | 1389 | / | *Terminus post quem* 1398 (1389 + 9) |
| P466-03-ech | 3rd from the bottom | 1394 | / | *Terminus post quem* 1403 (1394 + 9) |
| P466/04/1 | Top | 1399 | / | *Terminus post quem* 1408 (1399 + 9) |

The most recent ring (without sapwood) measured on the panel of the *Adoration of the Lamb* is dated to 1399, giving 1408 (1399 + 9) as the date from which this tree would have been felled, and the *terminus post quem* for support manufacture.

This result is consistent with those obtained in 1986 by J. Vynckier on the other panels of the lower section of the altarpiece[42]. Some sapwood was identified on certain pieces, which enables specification of the felling period of the trees – the broadest possible, according to our method of interpretation – as between 1415 and 1432[43]. Given the unknowable lapse of time between felling in the forest and construction of the support, we place the **creation of the panels of the lower section after 1415**.

## *6.2. Upper section of the altarpiece*

The table below lists the dates and felling estimations for the different trees used to make the planks of the panel of *God the Father*.

| Dendrochronological sequence | Plank | Last ring measured | Sapwood | Felling estimation |
|---|---|---|---|---|
| P463-02-03-ech | Right and central (from the front) | 1368 | / | *Terminus post quem* 1377 (1368 + 9) |

[40] See, for example, KEMPERDICK & KLEIN 1997. In this article, the authors propose adding 25 years to the date of the last ring measured. They specify, however, that this interval of 25 years is not appropriate for all of the works analyzed – it is sometimes too long. FRAITURE 2008; VANDEKERCHOVE, DEPYUDT-ELBAUM, FRAITURE & SANYOVA, in press.

[41] In effect, even when part of the sapwood is present, the lapse of time between felling and use of the wood remains unknown.

[42] VYNCKIER 1999-2000.

[43] The tree providing planks XI-A and XX-C has a last ring dated to 1404 and contains 9 sapwood rings. According to the broadest sapwood estimation (9-36 rings), we situate its felling between 1404 and 1432. On the other hand, the tree providing planks IX-A, XII-A, XVII-C and XIX-C has a last ring dated to 1406, without sapwood; the addition of the minimum 9 sapwood rings for "Baltic" oak yields a *terminus post quem* of 1415. Combining these data leads to an interval in common of 1415 – 1432 for the felling of the trees providing the planks of the lower section of the altarpiece (for the position of the planks in the altarpiece, see the schema in VYNCKIER 1999-2000, p. 238).

| | | | | |
|---|---|---|---|---|
| P463-01-P466-02-ech | Left (with a plank from the *Adoration* – see above) | 1389 | / | *Terminus post quem* 1398 (1389 + 9) |

The most recent ring, without sapwood, measured on the panel of *God the Father* is dated to 1389, giving 1398 (1389 + 9) as the date from which this tree would have been felled, and the *terminus post quem* for support manufacture.

The following table lists the dates and felling estimations for the different trees used to make the planks of the panel of *Saint John*.

| Dendrochronological sequence | Plank | Last ring measured | Sapwood | Felling estimation |
|---|---|---|---|---|
| P464-01-ech | Left (from the front) | 1412 | 6 rings | Between 1415 and 1442 |
| P464/02/2ab | Central | 1400 | / | *Terminus post quem* 1409 (1400 + 9) |
| P464/03/2 | Right | 1403 | / | *Terminus post quem* 1412 (1403 + 9) |

The sapwood preserved on one of the planks in the *Saint John* support permits placing the felling between 1415 and 1442. It remains impossible, however, to determine at what date, after 1415, the panel was made; we thus propose the *terminus post quem* of 1415 for support manufacture (1412 + 3)[44].

The next table lists the dates and felling estimations for the different trees used to make the planks of the panel of the *Virgin Mary*.

| Dendrochronological sequence | Plank | Last ring measured | Sapwood | Felling estimation |
|---|---|---|---|---|
| P465/01/1 | Left (from the front) | 1406 | 9 rings | Between 1406 and 1434 |
| P465/02/1 | Central | 1408 | / | *Terminus post quem* 1417 (1408 + 9) |
| P465/03/1b | Right | 1400 | / | *Terminus post quem* 1409 (1400 + 9) |

Taking into account the last ring measured on the panel of the *Virgin Mary* (1408) and the sapwood preserved on the left plank enables placing felling between 1417 and 1434. Once again, it is not possible to determine when, after 1417, the support was actually made; we propose the *terminus post quem* of 1417 for its manufacture (1408 + 9).

So, the new campaign of dendrochronological analysis refines the previously obtained results for the top of the altarpiece. Indeed, for the wing panels, J. Vynckier obtained a last ring dated to 1404 without sapwood[45], which according to our interpretation method, gives the dates of 1413 as *terminus post quem* for the felling. The results obtained for the panels of the central part now circumscribe **the felling of the oaks of the upper section of the altarpiece to 1417 – 1434**[46]. The unknown interval between felling and use of the wood in panels suggests situating the **manufacture of the support for the upper section of the altarpiece after 1417**.

[44] The minimum of sapwood is 9; 6 sapwood rings are preserved; thus 3 sapwood rings minimum are missing.
[45] VYNCKIER 1999-2000.
[46] The tree providing the left plank of the *Virgin Mary* has a last ring dated to 1406 and contains 9 sapwood rings. According to the broadest sapwood estimation (9-36 rings), its felling took place between 1406 and 1434. On the other hand, the tree providing the central plank of the same panel has a last ring dated to 1408, without sapwood; the addition of the minimum 9 sapwood rings for Baltic oak yields a *terminus post quem* of 1417. Combining these data leads to an interval in common of 1417 – 1434 for the felling of the trees providing the planks of the upper section of the altarpiece.

## *6.3. Planks produced from the same tree*

J. Vynckier demonstrated that different planks in the wing panels sections came from the same trees: for the 18 planks analyzed, he identified 10 trees[47].

Examination of the central parts reveals that a maximum of 11 trees provided the 13 planks. Two from the panel of *God the Father* came from a single oak; the same is true for the third element of this panel and a plank from the *Adoration of the Lamb*. Moreover, comparisons between these new data and data from 1986 indicate that a plank from the panel of the *Virgin Mary* came from the same tree as a plank from the panel of *Angels Playing Music* and its pendant on the *Virgin* in *grisaille*.

Finding planks originating from the same tree within a single group is not uncommon: such assemblages guarantee uniform behaviour of the work of art to changes in environmental conditions[48]. This is even less surprising when encountered in large-scale commissioned projects[49].

One point is nevertheless intriguing: the fact that we identified planks from the same tree in both the upper and lower sections of the altarpiece, although, based on observation of construction techniques, the supports for the two sections were made by different workshops[50]. However, this unique association – on the basis of the dendrochronological results – between the upper and the lower sections is a rather weak argument to definitively conclude that this was the work of a single panel maker, for an ensemble that numbers more than 30 elements, and which has several pairs or trios of planks from the same trees all located in the same part of the altarpiece.

In effect, this information could be explained in several different ways. It should be recalled that "Baltic" oaks were exported from the Hanseatic ports as semi-finished products – quartered trunks obtained by splitting or sawing, termed *waynscots*[51] –; the different pieces of a single trunk could thus have been sold to different wood merchants, joinery workshops or painting workshops, or even in different importing centres, from Bruges, which was a counter of the Hanse. Such *waynscots* would have then been split in two, three or even four planks before being used in panels[52]. In practice, the stocks of imported wood could thus have been distributed between workshops. It would, all the same, be extremely unlikely to find two planks from the same tree, prepared by different workshops and finally reunited in the same altarpiece…

What we can also assume, since the attribution of the different parts to Hubert or Jan van Eyck is still at the heart of discussions between specialists[53], is that planks stored with Hubert were later recovered by Jan. Further research on the production context of panels during this period would help to clarify this question.

[47] It should be recalled that these planks were sawn across their thickness. Each original plank of the altarpiece is thus, according to J. Vynckier, represented by two elements (except for those in the panel of the *Hermits*, the front now lost). VYNCKIER 1999-2000.
[48] For example, DEPUYDT-ELBAUM, FRAITURE & ROSIER 2010; HOUBRECHTS & VANDERVELLEN 2011.
[49] We can also cite, as another example, the folding sections of *Raising of the Cross* triptych by Rubens (VYNCKIER 1992).
[50] Jean-Albert Glatigny, pers. comm., Ghent, 09/06/2010.
[51] This explains why, to date, Baltic oak has only been found in the form of planks, or parts of planks as on sculpted altarpieces, in the importing countries of Western Europe. Based on sources, *waynscots* were mainly used for architectural or naval construction; from them also came the planks destined for panel manufacture. On this subject see, among others, SALZMAN 1979; BONDE, TYERS & WAZNY 1997; ZUNDE 1998-1999; TOSSAVAINEN 1994; WAZNY 2005; ECKSTEIN & WROBEL 2007.
[52] FRAITURE 2007.
[53] Hugo van der Velden, pers. comm., 01/2011.

## 7. Conclusions

This new campaign of dendrochronological analysis, focused on the four central panels of the *Ghent Altarpiece*, has yielded significant information that complements that already contributed by the study undertaken in 1986.

The 13 planks currently analyzed came from 11 Baltic oaks that are remarkable for several reasons. Most of them benefited from very slow and rather regular growth despite minor twisting on some trunks as seen by the medullary rays on several planks. Thee trees were centuries old, the oldest reaching 400 years. Their sizes are, moreover, more than respectable, considering that several planks are more than 30 cm wide. One plank in particular stands out from the others by its dendrochronological typology, its rapid growth rate and its relatively young age since it was not much more than 100 years old when it was felled.

Two times (three times in taking into account central panels with wings) a pair of planks from the same tree was identified; one pair on a single panel, the other on two distinct panels located on the upper and lower sections of the altarpiece (the third on two different panels in the upper section). This unexpected discovery could be explained in different ways. First, the supports for the two sections of the altarpiece could have been made in the same workshop – a hypothesis not supported by observation of construction techniques. Next, the planks could have arrived in the same lot of wood at the Bruges market and then distributed among two workshops (perhaps in different production centres) before being reunited in the altarpiece, through a combination of fairly extraordinary circumstances. Finally, the two planks could have been part of the stock of a workshop responsible for the production of part of the altarpiece; one plank would have thus been included and the other recovered by a workshop that continued the work. Regardless of the hypothesis preferred, it is useful to remember that these considerations concern only the manufacture of the supports, and not the execution of the paintings.

From the point of view of dating, the present study has identified the felling period of the trees used for the upper section, and thus makes it possible to compare the results obtained for nearly the entire altarpiece, by associating the data collected 25 years ago by J. Vynckier. In light of these new results, it appears that the two sections of the altarpiece, lower and upper, yielded dendrochronological dates that are extremely close since the trees for the lower section would have been felled between 1415 and 1432 and those for the upper section between 1417 and 1434. The close similarity of the two date ranges tends to support the conclusion that there was a single felling phase for the two sections. Nevertheless, the unknowns remaining (fluctuating number of sapwood rings, variable lapse of time between felling and use) prevent confirmation in terms of the period of support manufacture, and even less if the hypothesis of recovered stock is accepted for one of the two cases.

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# 10. Summary tables

## *10.1. Dates by plank/ by tree*

| Plank | Name of the dendrochronological sequence of the plank | Date of the last ring of the plank | Date of the last ring for the tree | Estimation for felling of the tree |
|---|---|---|---|---|
| Left plank of *God the Father* | P463/01/1 | 1385 | **1389** for the mean P463-01-P466-02-ech | *Terminus post quem* 1398 (1389 + 9) |
| Central plank of *God the Father* | P463/02/1 | 1368 | **1368** for the mean P463-02-03-ech | *Terminus post quem* 1377 (1368 + 9) |
| Right plank of *God the Father* | P463/03/1 | 1357 | **1368** for the mean P463-02-03-ech | *Terminus post quem* 1377 (1368 + 9) |
| Left plank of *Saint John* | P464-01-ech | 1412 | **1412** | Between 1415 and 1442 |
| Central plank of *Saint John* | P464/02/2 | 1400 | **1400** | *Terminus post quem* 1409 (1400 + 9) |
| Right plank of *Saint John* | P464/03/2ab | 1403 | **1403** | *Terminus post quem* 1412 (1403 + 9) |
| Left plank of the *Virgin Mary* | P465/01/1 | 1406 | **1406** | Between 1406 and 1434 |
| Central plank of the *Virgin Mary* | P465/02/1 | 1408 | **1408** | *Terminus post quem* 1417 (1408 + 9) |
| Right plank of the *Virgin Mary* | P465/03/1b | 1400 | **1400** | *Terminus post quem* 1409 (1400 + 9) |
| Bottom plank of the A*doration of the Lamb* | P466/01/1 | 1379 | **1379** | *Terminus post quem* 1388 (1379 + 9) |
| 2nd plank from the bottom of the A*doration of the Lamb* | P466/02/1 | 1389 | **1389** for the mean P463-01-P466-02-ech | *Terminus post quem* 1398 (1389 + 9) |
| 3rd plank from the bottom of the A*doration of the Lamb* | P466-03-ech | 1394 | **1394** | *Terminus post quem* 1403 (1394 + 9) |
| Top plank of the A*doration of the Lamb* | P466/04/1 | 1399 | **1399** | *Terminus post quem* 1408 (1399 + 9) |

## *10.2. Information recorded on the edges of the planks of the central panels*

| Dendro ID by plank | Plank location | Cutting method | Medullary rays | Tree | Growth rate | Mean ring (in 0.01 mm) | Number of rings measured | Plank width (cm) | Sequence measured |
|---|---|---|---|---|---|---|---|---|---|
| ***God the Father*** | | | | | | | | | |
| P463/01/1 | left plank, lower edge | full radial | curved | slightly twisted tree | very slow | 78 | 188 | 20.2 | lacks start (5 cm) |
| P463/01/2 | left plank, upper edge | radial | non-rectilinear, especially at the start of growth | | / | / | / | / | / |
| P463/02/1 | central plank, lower edge | full radial | not completely rectilinear | very slightly twisted tree | medium-slow, then slowing at the end | 111.28 | 296 | 32.7 | complete |
| P463/02/2 | central plank, upper edge | radial | rectilinear | | / | / | / | / | / |
| P463/03/1 | right plank, lower edge | full radial | not completely rectilinear | very slightly twisted tree | medium-slow, then slowing to very slow at the end | 104.68 | 225 | 30.4 | lacks start (6,5 cm) |
| P463/03/2 | right plank, upper edge | radial | rectilinear | | / | / | / | / | / |
| ***Saint John*** | | | | | | | | | |
| P464/01/1 | left plank, lower edge | full radial | sinuous | irregular growth | rapid | 213.77 | 96 | 24.3 | lacks start (2,5 cm) |
| P464/01/2 | left plank, upper edge | full radial | sinuous | | rapid | 211.42 | 79 | 23.4 | lacks start (4,5 cm) |
| P464/02/1 | central plank, lower edge | full radial | slightly curved | slightly irregular growth | / | / | / | / | / |
| P464/02/2 | central plank, upper edge | radial | fairly sinuous | | medium-slow with slight slowing at the end | 152.42 | 151 | 28.3 | lacks start (5 cm) |
| P464/03/1 | right plank, lower edge | full radial | sinuous, especially at the end | slightly irregular growth | / | / | / | / | / |
| P464/03/2 | right plank, upper edge | full radial | slightly sinuous | | slow to very slow | 114.68 | 197 | 23.5 | complete |
| ***Virgin*** | | | | | | | | | |
| P465/01/1 | left plank, lower edge | full radial | very slightly curved at the end | very slightly twisted tree | very slow | 77.7 | 203 | 26.8 | lacks start (10 cm) |
| P465/01/2 | left plank, upper edge | full radial | (non discernible) | | / | / | / | / | / |
| P465/02/1 | central plank, lower edge | full radial | curved | slightly twisted tree | rather rapid | 157.5 | 151 | 24 | complete |
| P465/02/2 | central plank, upper edge | full radial | curved | | / | / | / | / | / |
| P465/03/1 | right plank, lower edge | full radial | non-rectilinear, especially at the start of growth | slighted twisted tree at start of growth | irregular then very slow at the end | 90.71 | 168 | 25.1 | lacks start (7 cm) |
| P465/03/2 | right plank, upper edge | radial | rectilinear | | / | / | / | / | / |
| ***Adoration of the Mystic Lamb*** | | | | | | | | | |
| P466/01/1 | bottom plank, left edge | radial | curved at the end | slighted twisted tree at end of growth | medium-slow, slowing slightly and gradually to the end | 129.43 | 233 | 33.2 | complete |
| P466/01/2 | bottom plank, right edge | full radial | (non discernible) | | / | / | / | / | / |
| P466/02/1 | 2nd plank from the bottom, left edge | full radial | slightly curved | slightly twisted tree | medium-slow, then becoming slow at the end | 98.58 | 354 | 34.8 | complete |
| P466/02/2 | 2nd plank from the bottom, right edge | radial | curved | | / | / | / | / | / |
| P466/03/1 | 3rd plank from the bottom, left edge | full radial | slightly curved | slightly twisted tree | fairly irregular but slow | 104.13 | 357 | 36.4 | complete |
| P466/03/2 | 3rd plank from the bottom, right edge | radial | (non discernible) | | / | 96.84 | 58 | 36.8 | includes only extreme end |
| P466/04/1 | top plank, left edge | radial | very slightly curved | slightly twisted tree | medium-slow, slightly slowing | 136.9 | 227 | 32.5 | complete |
| P466/04/2 | top plank, right edge | full radial | very slightly curved | | / | / | / | / | / |

## 11. Dendrochronological data

*11.1. Natural values* for the 11 chronologies representative of the 11 trees identified for the central panels of the altarpiece (accuracy: 0.01 mm)

11.1.1. P463-02-03-ech, dendrochronological mean for the right and central planks of *God the Father*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 155 | 187 | 169 | 139 | 181 | 136 | 163 | 92 | 96 | 135 |
| 124 | 166 | 196 | 174 | 119 | 120 | 157 | 116 | 102 | 147 |
| 127 | 145 | 169 | 187 | 179 | 186 | 171 | 168 | 129 | 134 |
| 156 | 133 | 167 | 150 | 209 | 152 | 136 | 151 | 144 | 141 |
| 152 | 155 | 156 | 199 | 123 | 154 | 148 | 186 | 184 | 135 |
| 146 | 147 | 108 | 99 | 91 | 120 | 99 | 137 | 112 | 139 |
| 100 | 110 | 134 | 159 | 106 | 144 | 112 | 136 | 152 | 152 |
| 166 | 145 | 148 | 114 | 119 | 124 | 146 | 108 | 96 | 94 |
| 142 | 140 | 130 | 98 | 126 | 120 | 125 | 130 | 106 | 95 |
| 124 | 145 | 136 | 104 | 92 | 132 | 92 | 128 | 108 | 98 |
| 105 | 105 | 100 | 102 | 121 | 128 | 132 | 128 | 148 | 123 |
| 150 | 121 | 146 | 140 | 151 | 140 | 147 | 154 | 106 | 85 |
| 106 | 114 | 124 | 129 | 126 | 161 | 134 | 144 | 124 | 110 |
| 126 | 98 | 124 | 104 | 101 | 121 | 108 | 120 | 118 | 101 |
| 108 | 123 | 92 | 119 | 104 | 114 | 148 | 106 | 82 | 82 |
| 80 | 60 | 96 | 94 | 100 | 108 | 118 | 110 | 119 | 119 |
| 106 | 83 | 80 | 76 | 108 | 68 | 86 | 98 | 67 | 80 |
| 108 | 70 | 83 | 95 | 115 | 112 | 93 | 132 | 122 | 116 |
| 144 | 133 | 142 | 157 | 112 | 134 | 125 | 97 | 119 | 107 |
| 80 | 84 | 87 | 94 | 98 | 112 | 110 | 112 | 166 | 137 |
| 141 | 122 | 116 | 100 | 111 | 82 | 110 | 100 | 134 | 105 |
| 134 | 110 | 123 | 123 | 115 | 98 | 98 | 72 | 90 | 74 |
| 76 | 104 | 77 | 106 | 100 | 101 | 120 | 117 | 115 | 120 |
| 120 | 67 | 107 | 83 | 70 | 78 | 86 | 70 | 68 | 94 |
| 101 | 92 | 94 | 102 | 92 | 70 | 92 | 94 | 71 | 90 |
| 95 | 77 | 90 | 96 | 88 | 78 | 70 | 90 | 66 | 70 |
| 62 | 76 | 70 | 64 | 75 | 78 | 64 | 58 | 50 | 50 |
| 50 | 66 | 55 | 64 | 64 | 46 | 61 | 54 | 46 | 42 |
| 52 | 50 | 54 | 60 | 43 | 61 | 48 | 63 | 46 | 57 |
| 67 | 51 | 69 | 74 | 37 | 57 | ; | | | |

11.1.2. P463-01-P466-02-ech, dendrochronological mean for the left plank of *God the Father* and the 2nd plank from the bottom of the *Adoration of the Lamb*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 161 | 223 | 178 | 175 | 192 | 184 | 172 | 206 | 164 | 195 |
| 125 | 178 | 202 | 168 | 171 | 176 | 216 | 176 | 193 | 196 |
| 139 | 125 | 68 | 114 | 158 | 149 | 113 | 118 | 118 | 82 |
| 113 | 110 | 147 | 93 | 104 | 96 | 104 | 116 | 148 | 118 |
| 98 | 143 | 98 | 131 | 84 | 87 | 134 | 101 | 118 | 143 |
| 185 | 92 | 126 | 140 | 75 | 97 | 105 | 136 | 116 | 119 |
| 130 | 122 | 138 | 146 | 113 | 119 | 113 | 94 | 97 | 130 |
| 116 | 150 | 163 | 110 | 111 | 121 | 158 | 137 | 147 | 123 |
| 134 | 105 | 115 | 100 | 136 | 138 | 135 | 140 | 119 | 138 |
| 117 | 105 | 125 | 73 | 91 | 107 | 125 | 118 | 99 | 124 |
| 102 | 85 | 118 | 102 | 101 | 113 | 121 | 159 | 145 | 133 |
| 126 | 137 | 123 | 128 | 112 | 71 | 102 | 145 | 142 | 112 |
| 93 | 109 | 93 | 109 | 122 | 100 | 94 | 102 | 110 | 94 |
| 120 | 80 | 124 | 92 | 100 | 59 | 102 | 92 | 102 | 108 |
| 102 | 84 | 108 | 112 | 80 | 98 | 76 | 110 | 98 | 88 |
| 98 | 120 | 111 | 90 | 148 | 114 | 86 | 90 | 98 | 94 |
| 82 | 100 | 110 | 102 | 116 | 94 | 90 | 98 | 76 | 90 |
| 90 | 66 | 90 | 78 | 94 | 82 | 86 | 75 | 92 | 72 |
| 98 | 113 | 99 | 142 | 102 | 82 | 75 | 66 | 66 | 101 |
| 70 | 99 | 84 | 97 | 108 | 94 | 98 | 100 | 87 | 82 |
| 82 | 92 | 64 | 70 | 68 | 58 | 66 | 98 | 64 | 66 |
| 82 | 93 | 86 | 94 | 82 | 86 | 110 | 96 | 94 | 118 |
| 129 | 111 | 102 | 96 | 72 | 88 | 78 | 70 | 62 | 68 |
| 89 | 76 | 88 | 85 | 92 | 110 | 106 | 107 | 99 | 102 |
| 72 | 92 | 70 | 82 | 76 | 88 | 86 | 94 | 82 | 92 |
| 92 | 86 | 87 | 74 | 72 | 74 | 70 | 60 | 82 | 72 |
| 94 | 92 | 94 | 102 | 105 | 90 | 131 | 94 | 64 | 91 |
| 74 | 68 | 58 | 70 | 64 | 58 | 75 | 100 | 76 | 68 |
| 89 | 80 | 65 | 85 | 76 | 73 | 89 | 73 | 78 | 70 |
| 78 | 70 | 70 | 62 | 74 | 63 | 55 | 50 | 59 | 73 |
| 63 | 74 | 59 | 80 | 57 | 53 | 54 | 48 | 59 | 67 |
| 72 | 62 | 54 | 53 | 58 | 56 | 44 | 50 | 56 | 56 |
| 68 | 54 | 66 | 60 | 60 | 40 | 61 | 60 | 79 | 70 |
| 68 | 62 | 61 | 56 | 62 | 64 | 57 | 76 | 54 | 72 |
| 52 | 58 | 64 | 66 | 80 | 93 | 76 | 84 | 58 | 56 |
| 70 | 58 | 56 | 58 | ; | | | | | |

11.1.3. P464-01-ech, dendrochronological sequence for the left plank of *Saint John*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 410 | 329 | 243 | 299 | 284 | 307 | 204 | 146 | 275 | 157 |
| 239 | 238 | 202 | 299 | 216 | 161 | 144 | 252 | 154 | 186 |
| 85 | 152 | 160 | 184 | 176 | 121 | 158 | 154 | 164 | 112 |
| 136 | 160 | 140 | 176 | 180 | 208 | 228 | 265 | 55 | 144 |
| 210 | 192 | 273 | 232 | 149 | 168 | 240 | 182 | 218 | 166 |
| 176 | 195 | 244 | 234 | 206 | 212 | 145 | 196 | 204 | 172 |
| 143 | 246 | 268 | 206 | 334 | 266 | 369 | 282 | 299 | 262 |
| 328 | 279 | 305 | 338 | 242 | 331 | 288 | 264 | 255 | 250 |
| 181 | 240 | 222 | 199 | 98 | 118 | 100 | 92 | 180 | 285 |
| 227 | 253 | , | , | , | , | ; | | | |

11.1.4. P464/02/2ab, dendrochronological sequence for the central plank of *Saint John*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 145 | 172 | 126 | 205 | 204 | 184 | 147 | 175 | 116 | 124 |
| 145 | 122 | 133 | 141 | 126 | 111 | 102 | 69 | 86 | 100 |
| 108 | 131 | 129 | 141 | 98 | 88 | 102 | 109 | 86 | 82 |
| 82 | 67 | 70 | 71 | 64 | 63 | 72 | 63 | 74 | 67 |
| 67 | 61 | 79 | 88 | 104 | 100 | 94 | 116 | 130 | 143 |
| 114 | 83 | 111 | 86 | 82 | 120 | 147 | 116 | 123 | 130 |
| 127 | 133 | 153 | 152 | 178 | 126 | 117 | 130 | 115 | 72 |
| 80 | 99 | 101 | 97 | 124 | 107 | 141 | 140 | 128 | 101 |
| 115 | 93 | 147 | 185 | 194 | 169 | 155 | 190 | 189 | 238 |
| 222 | 222 | 197 | 152 | 144 | 162 | 162 | 131 | 109 | 101 |
| 109 | 115 | 115 | 86 | 97 | 101 | 105 | 103 | 136 | 152 |
| 138 | 95 | 97 | 115 | 123 | 144 | 117 | 95 | 114 | 113 |
| 116 | 122 | 94 | 93 | 91 | 112 | 84 | 93 | 120 | 95 |
| 122 | 96 | 120 | , | , | , | 151 | 129 | 109 | 114 |
| 105 | 110 | 101 | 107 | 77 | 120 | 109 | 118 | 118 | 151 |
| 132 | 107 | 108 | 133 | 114 | 101 | 78 | 87 | 80 | 106 |
| 108 | 99 | 108 | 114 | 108 | 108 | 118 | 106 | 93 | 76 |
| 108 | 104 | 98 | 106 | 123 | 111 | 100 | 96 | 115 | 105 |
| 96 | 106 | 94 | 84 | 88 | 84 | 108 | 117 | 69 | 74 |
| 74 | 104 | 99 | 115 | 78 | 74 | 94 | ; | | |

11.1.5. P464/03/2, dendrochronological sequence for the right plank of *Saint John*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 124 | 96 | 117 | 126 | 98 | 249 | 190 | 194 | 112 | 152 |
| 120 | 116 | 140 | 144 | 196 | 152 | 278 | 199 | 243 | 245 |
| 245 | 340 | 160 | 179 | 151 | 242 | 145 | 104 | 131 | 157 |
| 145 | 183 | 141 | 94 | 107 | 142 | 123 | 125 | 109 | 98 |
| 150 | 157 | 175 | 139 | 126 | 158 | 212 | 155 | 198 | 163 |
| 126 | 179 | 187 | 143 | 95 | 81 | 97 | 153 | 128 | 173 |
| 127 | 120 | 155 | 219 | 162 | 145 | 249 | 149 | 186 | 189 |
| 175 | 158 | 188 | 214 | 89 | 118 | 146 | 169 | 163 | 155 |
| 148 | 128 | 131 | 97 | 159 | 167 | 201 | 169 | 239 | 232 |
| 158 | 148 | 175 | 163 | 156 | 148 | 136 | 148 | 156 | 117 |
| 134 | 198 | 180 | 213 | 197 | 188 | 235 | 147 | 127 | 193 |
| 148 | 87 | 110 | 154 | 133 | 146 | 190 | 171 | 185 | 229 |
| 165 | 123 | 125 | 81 | 102 | 149 | 145 | 97 | 200 | 119 |
| 137 | 88 | 90 | 150 | 86 | 136 | 108 | 128 | 132 | 135 |
| 110 | 164 | 121 | 132 | 118 | 88 | 78 | 69 | 116 | 141 |
| 158 | ; | | | | | | | | |

11.1.6. P465/01/1, dendrochronological sequence for the left plank of the *Virgin Mary*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 116 | 110 | 119 | 110 | 102 | 76 | 102 | 102 | 105 | 74 |
| 108 | 76 | 105 | 94 | 88 | 93 | 89 | 81 | 77 | 54 |
| 63 | 101 | 75 | 58 | 81 | 91 | 93 | 79 | 87 | 93 |
| 83 | 69 | 65 | 91 | 79 | 81 | 63 | 61 | 65 | 67 |
| 67 | 95 | 79 | 71 | 59 | 55 | 63 | 79 | 75 | 77 |
| 73 | 94 | 73 | 69 | 73 | 84 | 73 | 69 | 90 | 104 |
| 110 | 83 | 121 | 71 | 73 | 81 | 81 | 73 | 90 | 83 |
| 79 | 71 | 50 | 73 | 60 | 69 | 58 | 81 | 62 | 77 |
| 75 | 69 | 60 | 75 | 76 | 90 | 71 | 67 | 84 | 86 |
| 115 | 93 | 86 | 90 | 97 | 105 | 97 | 107 | 124 | 69 |
| 83 | 89 | 115 | 73 | 85 | 75 | 79 | 73 | 102 | 71 |
| 65 | 77 | 81 | 57 | 61 | 92 | 65 | 83 | 96 | 77 |
| 54 | 106 | 75 | 86 | 92 | 80 | 74 | 76 | 92 | 61 |
| 70 | 68 | 58 | 96 | 80 | 94 | 88 | 88 | 70 | 70 |
| 60 | 103 | 86 | 53 | 88 | 76 | 80 | 84 | 78 | 76 |
| 74 | 61 | 77 | 76 | 71 | 122 | 68 | 76 | 87 | 75 |
| 69 | 76 | 80 | 80 | 69 | 64 | 64 | 74 | 68 | 86 |
| 76 | 61 | 59 | 54 | 51 | 61 | 48 | 47 | 47 | 52 |
| 49 | 57 | 53 | 48 | 53 | 65 | 71 | 77 | 66 | 55 |
| 87 | 46 | 70 | 77 | 99 | 83 | 63 | 60 | 67 | 49 |
| 60 | 69 | 85 | ; | | | | | | |

11.1.7. P465/02/1, dendrochronological sequence for the central plank of the *Virgin Mary*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 195 | 238 | 239 | 179 | 232 | 212 | 197 | 343 | 296 | 183 |
| 177 | 166 | 167 | 262 | 187 | 170 | 230 | 200 | 189 | 123 |
| 92 | 149 | 157 | 166 | 170 | 127 | 121 | 151 | 176 | 142 |
| 144 | 152 | 115 | 132 | 171 | 130 | 169 | 218 | 199 | 162 |
| 160 | 168 | 180 | 153 | 157 | 176 | 115 | 111 | 94 | 118 |
| 136 | 135 | 148 | 142 | 174 | 174 | 182 | 174 | 239 | 182 |
| 144 | 184 | 155 | 163 | 188 | 148 | 127 | 180 | 156 | 182 |
| 152 | 129 | 199 | 169 | 123 | 129 | 207 | 129 | 167 | 125 |
| 119 | 142 | 136 | 159 | 133 | 135 | 113 | 119 | 104 | 138 |
| 108 | 99 | 110 | 116 | 108 | 104 | 100 | 182 | 142 | 151 |
| 128 | 124 | 167 | 121 | 151 | 184 | 118 | 152 | 116 | 150 |
| 164 | 114 | 166 | 147 | 125 | 113 | 120 | 141 | 163 | 108 |
| 176 | 130 | 198 | 181 | 143 | 176 | 157 | 167 | 145 | 172 |
| 139 | 198 | 170 | 143 | 174 | 118 | 162 | 163 | 162 | 119 |
| 118 | 141 | 176 | 165 | 165 | 157 | 158 | 155 | 199 | 188 |
| 175 | ; | | | | | | | | |

11.1.8. P465/03/1b, dendrochronological sequence for the right plank of the *Virgin Mary*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 71 | 54 | 66 | 77 | 54 | 70 | 56 | 52 | 56 | 67 |
| 59 | 33 | 64 | 37 | 58 | 63 | 47 | 93 | 91 | 80 |
| 77 | 77 | 121 | 89 | 91 | 77 | 73 | 79 | 75 | 105 |
| 73 | 141 | 91 | 126 | 107 | 82 | 82 | 111 | 101 | 95 |
| 90 | 105 | 95 | 82 | 80 | 86 | 86 | 77 | 116 | 99 |
| 92 | 77 | 101 | 116 | 67 | 105 | 77 | 118 | 137 | 94 |
| 90 | 145 | 111 | 117 | 135 | 96 | 154 | 107 | 115 | 160 |
| 126 | 81 | 79 | 77 | 126 | 113 | 129 | 97 | 105 | 99 |
| 141 | 93 | 87 | 100 | 115 | 80 | 89 | 94 | 92 | 97 |
| 107 | 96 | 113 | 98 | 104 | 108 | 110 | 86 | 79 | 77 |
| 71 | 84 | 88 | 86 | 86 | 104 | 100 | 65 | 79 | 67 |
| 79 | 71 | 72 | 73 | 93 | 74 | 67 | 65 | 60 | 58 |
| 74 | 72 | 83 | 79 | 97 | 95 | 101 | 95 | 92 | 71 |
| 94 | 79 | 116 | 132 | 93 | 115 | 106 | 104 | 96 | 88 |
| 87 | 94 | 115 | 85 | 96 | 154 | 108 | 94 | 114 | 94 |
| 116 | 82 | 97 | 80 | 102 | 102 | 102 | 68 | 75 | 92 |
| 75 | 70 | 53 | 101 | 70 | 89 | 58 | 94 | ; | |

11.1.9. P466/01/1, dendrochronological sequence for the bottom plank of the *Adoration of the Lamb*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 277 | 230 | 331 | 171 | 93 | 193 | 216 | 281 | 257 | 151 |
| 230 | 216 | 257 | 336 | 203 | 201 | 145 | 146 | 126 | 124 |
| 132 | 190 | 107 | 162 | 105 | 133 | 182 | 175 | 148 | 143 |
| 111 | 207 | 245 | 151 | 223 | 137 | 202 | 122 | 183 | 202 |
| 182 | 174 | 125 | 304 | 150 | 86 | 124 | 138 | 174 | 166 |
| 188 | 301 | 176 | 234 | 206 | 133 | 205 | 158 | 190 | 130 |
| 152 | 189 | 166 | 193 | 147 | 162 | 208 | 166 | 104 | 123 |
| 117 | 183 | 193 | 132 | 130 | 115 | 108 | 122 | 110 | 129 |
| 162 | 114 | 119 | 130 | 110 | 122 | 118 | 140 | 124 | 104 |
| 152 | 101 | 90 | 93 | 85 | 80 | 113 | 75 | 71 | 81 |
| 85 | 102 | 117 | 157 | 123 | 124 | 164 | 160 | 171 | 131 |
| 126 | 68 | 113 | 83 | 92 | 89 | 101 | 74 | 95 | 112 |
| 96 | 88 | 119 | 86 | 155 | 126 | 128 | 122 | 137 | 102 |
| 130 | 74 | 124 | 117 | 136 | 125 | 143 | 97 | 120 | 121 |
| 124 | 125 | 132 | 102 | 113 | 90 | 98 | 164 | 103 | 127 |
| 118 | 125 | 132 | 133 | 133 | 171 | 149 | 107 | 142 | 83 |
| 93 | 111 | 143 | 91 | 117 | 123 | 140 | 115 | 147 | 145 |
| 99 | 110 | 114 | 122 | 120 | 143 | 114 | 67 | 86 | 97 |
| 80 | 101 | 86 | 93 | 68 | 83 | 73 | 57 | 77 | 84 |
| 92 | 83 | 92 | 68 | 71 | 71 | 66 | 66 | 73 | 77 |
| 60 | 70 | 53 | 82 | 83 | 83 | 89 | 62 | 67 | 77 |
| 76 | 69 | 66 | 92 | 92 | 98 | 100 | 109 | 69 | 98 |
| 101 | 92 | 115 | 117 | 104 | 97 | 101 | 131 | 136 | 129 |
| 104 | 147 | 106 | ; | | | | | | |

11.1.10. P466-03-ech, dendrochronological sequence for the 3rd plank from the bottom of the *Adoration of the Lamb*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 196 | 159 | 153 | 173 | 164 | 164 | 105 | 122 | 94 | 93 |
| 91 | 116 | 130 | 139 | 145 | 125 | 124 | 120 | 87 | 57 |
| 52 | 98 | 136 | 146 | 103 | 143 | 134 | 83 | 103 | 88 |
| 127 | 92 | 82 | 68 | 109 | 118 | 135 | 145 | 122 | 116 |
| 105 | 147 | 139 | 134 | 164 | 116 | 110 | 176 | 153 | 104 |
| 138 | 110 | 122 | 107 | 152 | 129 | 117 | 87 | 100 | 113 |
| 170 | 169 | 161 | 119 | 132 | 82 | 105 | 134 | 156 | 155 |
| 128 | 136 | 108 | 126 | 134 | 111 | 118 | 121 | 148 | 92 |
| 132 | 120 | 108 | 145 | 146 | 115 | 153 | 131 | 80 | 81 |
| 118 | 58 | 154 | 124 | 102 | 100 | 111 | 117 | 120 | 93 |
| 126 | 96 | 124 | 134 | 104 | 134 | 156 | 132 | 150 | 135 |
| 167 | 155 | 95 | 91 | 77 | 145 | 99 | 111 | 122 | 104 |
| 106 | 115 | 116 | 116 | 85 | 108 | 106 | 114 | 102 | 91 |
| 114 | 81 | 91 | 64 | 81 | 122 | 108 | 108 | 89 | 77 |
| 116 | 93 | 94 | 118 | 77 | 114 | 88 | 83 | 112 | 110 |
| 73 | 93 | 147 | 122 | 59 | 106 | 88 | 124 | 83 | 94 |
| 120 | 128 | 141 | 88 | 105 | 96 | 90 | 94 | 84 | 95 |
| 109 | 93 | 125 | 105 | 113 | 113 | 105 | 90 | 134 | 107 |
| 129 | 154 | 108 | 90 | 73 | 69 | 94 | 96 | 90 | 110 |
| 96 | 102 | 116 | 98 | 100 | 110 | 92 | 84 | 73 | 81 |
| 73 | 84 | 51 | 73 | 65 | 85 | 63 | 91 | 104 | 120 |
| 108 | 140 | 116 | 116 | 118 | 128 | 118 | 126 | 126 | 93 |
| 85 | 98 | 91 | 69 | 69 | 71 | 83 | 79 | 97 | 84 |
| 97 | 95 | 90 | 99 | 90 | 99 | 70 | 101 | 68 | 121 |
| 86 | 109 | 111 | 107 | 94 | 121 | 101 | 109 | 105 | 97 |
| 84 | 86 | 97 | 80 | 80 | 76 | 108 | 86 | 104 | 91 |
| 84 | 95 | 71 | 93 | 93 | 63 | 82 | 88 | 65 | 56 |
| 80 | 65 | 67 | 71 | 97 | 100 | 67 | 102 | 106 | 95 |
| 86 | 115 | 108 | 95 | 98 | 84 | 67 | 86 | 78 | 97 |
| 71 | 71 | 71 | 78 | 82 | 49 | 73 | 81 | 73 | 88 |
| 77 | 87 | 61 | 82 | 56 | 70 | 76 | 90 | 83 | 86 |
| 80 | 94 | 100 | 100 | 86 | 100 | 76 | 98 | 78 | 80 |
| 88 | 117 | 106 | 87 | 95 | 110 | 136 | 131 | 100 | 117 |
| 142 | 116 | 102 | 114 | 80 | 109 | 81 | 106 | 88 | 115 |
| 101 | 96 | 113 | 124 | 102 | 103 | 84 | 81 | 96 | 74 |
| 96 | 91 | 96 | 116 | 116 | 67 | 103 | ; | | |

11.1.11. P466/04/1, dendrochronological sequence for the top plank of the *Adoration of the Lamb*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 184 | 213 | 157 | 146 | 111 | 150 | 169 | 148 | 206 | 282 |
| 284 | 196 | 216 | 286 | 296 | 222 | 256 | 281 | 261 | 153 |
| 150 | 190 | 203 | 241 | 279 | 208 | 251 | 266 | 167 | 134 |
| 170 | 189 | 165 | 213 | 164 | 181 | 163 | 119 | 151 | 155 |
| 149 | 142 | 95 | 108 | 112 | 97 | 125 | 118 | 97 | 110 |
| 98 | 59 | 133 | 108 | 118 | 135 | 111 | 139 | 111 | 135 |
| 137 | 171 | 140 | 130 | 157 | 147 | 134 | 117 | 90 | 105 |
| 114 | 90 | 90 | 108 | 156 | 134 | 156 | 159 | 186 | 187 |
| 182 | 140 | 183 | 176 | 126 | 135 | 148 | 142 | 113 | 128 |
| 110 | 143 | 121 | 145 | 127 | 198 | 175 | 165 | 158 | 162 |
| 154 | 155 | 165 | 141 | 143 | 122 | 161 | 130 | 143 | 156 |
| 82 | 161 | 147 | 134 | 116 | 130 | 126 | 114 | 136 | 126 |
| 111 | 144 | 124 | 157 | 140 | 127 | 136 | 90 | 137 | 173 |
| 165 | 94 | 105 | 94 | 102 | 112 | 122 | 114 | 101 | 123 |
| 120 | 137 | 126 | 147 | 133 | 90 | 130 | 114 | 99 | 110 |
| 120 | 91 | 91 | 88 | 89 | 100 | 93 | 88 | 98 | 84 |
| 83 | 91 | 112 | 108 | 100 | 123 | 129 | 104 | 104 | 97 |
| 115 | 120 | 124 | 124 | 93 | 86 | 107 | 103 | 132 | 105 |
| 111 | 109 | 111 | 111 | 103 | 128 | 119 | 125 | 74 | 113 |
| 149 | 139 | 137 | 122 | 131 | 137 | 123 | 130 | 114 | 108 |
| 106 | 95 | 131 | 111 | 124 | 126 | 133 | 137 | 140 | 120 |
| 133 | 103 | 140 | 97 | 128 | 129 | 139 | 106 | 118 | 137 |
| 111 | 113 | 109 | 99 | 66 | 113 | , | ; | | |

*11.2. Synchronisation calculations* between the 11 chronologies representative of the 11 trees identified for the central panels and the reference database chronologies

Synchronisation calculations were made using the *Dendron II* system, after having calibrated the dendrochronological series by an original transformation termed the *adjusted corridor*[1]. The principle of the test in *Dendron II* is derived from the Student test, using two correlation coefficients (cor1 and cor2)[2]. The dendrochronologist selects the exact position of the wood being dated from the most probable positions proposed by *Dendron II*,

- based on the best correlation coefficient (Student's *t*) obtained with a limited risk of errors (probability/security): the *t* result is considered significant above 3.5, good above 4 and very good above 5[3]
- and the recurrence of this position given by different chronologies in the reference database (*replication*)[4].

The reference database that enables the planks from the altarpiece to be dated includes the following chronologies:

- *BALTIC1* and *BALTIC2*, master chronologies constructed by HILLAM & TYERS (1995) on the basis of artistic and archaeological materials.
- *BALTIC0*, master chronology constructed by I. Tyers (unpublished), on the basis of archaeological and artistic materials.
- *NiederlandeNord*, master chronology constructed by P. Klein (unpublished), on the basis of artistic materials.
- *Bowhill* and *HMC* 94, site chronologies constructed by C. Groves-Tyers and/or I. Tyers: the first includes planks of a ceiling in Exeter, Devon (GROVES 2004); the second includes caskets from Hull, Yorkshire (unpublished).
- nearly 250 individual chronologies of panels from the Southern Netherlands in the 15th century (IRPA/KIK, J. Vynckier and P. Fraiture, unpublished. Ref. *JVk/PaF_2008(KIK_IRPA)*).

In the tables below only the highest results for the positions retained are presented (Student's $t > 4$).

11.2.1. P463-02-03-ech, dendrochronological mean for the right and central planks of *God the Father*

The dendrochronological mean P463-02-03-ech procures very good results. Replication is significant among the chronologies from the reference database that covers the region and period for this tree-ring series since nearly 30 chronologies reproduce the result retained, **1073 – 1368**, with significant test rates, of which half give high synchronisation rates (with a maximum of $t = 6.8$).

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 296 | 0.45 | 0.42 | 6.80 | 1.0000 | 1073 | 1368 | BALTIC0 |
| 196 | 0.49 | 0.31 | 6.05 | 1.0000 | 1073 | 1368 | P123C |
| 196 | 0.44 | 0.27 | 5.25 | 1.0000 | 1073 | 1368 | P223A3.ECH |
| 196 | 0.37 | 0.33 | 5.16 | 1.0000 | 1073 | 1368 | P46A |
| 101 | 0.50 | 0.42 | 5.12 | 1.0000 | 1073 | 1368 | P47G |
| 178 | 0.41 | 0.30 | 5.05 | 1.0000 | 1073 | 1368 | P39 |
| 296 | 0.37 | 0.27 | 4.79 | 1.0000 | 1073 | 1368 | P137 |
| 296 | 0.41 | 0.23 | 4.78 | 1.0000 | 1073 | 1368 | P149C |
| 156 | 0.46 | 0.26 | 4.76 | 0.9999 | 1073 | 1368 | P207.ECH |
| 221 | 0.37 | 0.24 | 4.51 | 0.9999 | 1073 | 1368 | BALTIC1 |
| 177 | 0.35 | 0.29 | 4.48 | 0.9999 | 1073 | 1368 | P199ABC.ECH |
| 225 | 0.33 | 0.26 | 4.32 | 0.9999 | 1073 | 1368 | P46B |
| 262 | 0.34 | 0.22 | 4.17 | 0.9999 | 1073 | 1368 | HMC94 |
| 179 | 0.29 | 0.29 | 4.05 | 0.9999 | 1073 | 1368 | P138 |

[1] LAMBERT 2006.
[2] LAMBERT 2006.
[3] FRAITURE 2007.
[4] FRAITURE 2007.

11.2.2. P463-01-P466-02-ech, dendrochronological mean for the left plank of *God the Father* and the 2nd plank from the bottom of the *Adoration of the Lamb*

The dendrochronological mean P463-01-P466-02-ech procures excellent results. Replication is very strong since more than 50 chronologies covering the region and period of this tree-ring series reproduce the result retained, **1036 – 1389**, with significant synchronisation rates, and many chronologies with high synchronisation rates (9 chronologies with a Student's $t > 5$, with a maximum of 6.3).

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 111 | 0.54 | 0.50 | 6.30 | 1.0000 | 1036 | 1389 | P238 |
| 101 | 0.54 | 0.47 | 5.88 | 1.0000 | 1036 | 1389 | P47G |
| 119 | 0.49 | 0.45 | 5.74 | 1.0000 | 1036 | 1389 | P237C |
| 354 | 0.41 | 0.33 | 5.64 | 1.0000 | 1036 | 1389 | P149C |
| 177 | 0.45 | 0.33 | 5.61 | 1.0000 | 1036 | 1389 | P207.ECH |
| 200 | 0.35 | 0.38 | 5.56 | 1.0000 | 1036 | 1389 | P138 |
| 338 | 0.43 | 0.29 | 5.43 | 1.0000 | 1036 | 1389 | BALTIC0 |
| 217 | 0.40 | 0.30 | 5.30 | 1.0000 | 1036 | 1389 | P123C |
| 131 | 0.56 | 0.26 | 5.05 | 1.0000 | 1036 | 1389 | P226MC |
| 226 | 0.35 | 0.31 | 4.90 | 1.0000 | 1036 | 1389 | P46D |
| 217 | 0.46 | 0.18 | 4.79 | 1.0000 | 1036 | 1389 | P223A3.ECH |
| 246 | 0.37 | 0.26 | 4.69 | 0.9999 | 1036 | 1389 | P46B |
| 199 | 0.39 | 0.24 | 4.66 | 0.9999 | 1036 | 1389 | P39 |
| 180 | 0.35 | 0.28 | 4.43 | 0.9999 | 1036 | 1389 | P47E |
| 132 | 0.58 | 0.13 | 4.37 | 0.9999 | 1036 | 1389 | P41 |
| 242 | 0.35 | 0.22 | 4.21 | 0.9999 | 1036 | 1389 | BALTIC1 |
| 234 | 0.35 | 0.22 | 4.19 | 0.9999 | 1036 | 1389 | P149AB.ECH |
| 217 | 0.22 | 0.34 | 4.12 | 0.9999 | 1036 | 1389 | P46A |
| 193 | 0.36 | 0.20 | 4.01 | 0.9999 | 1036 | 1389 | P206.ECH |

11.2.3. P464-01-ech, left plank of *Saint John*

The chronology P464-01-ech procures acceptable results to retain the proposed date of **1317 – 1412**: while replication is low (only 12 chronologies of the database provide the result retained with significant synchronisation rates), we nonetheless obtain two correlations of very good quality (Student's $t > 5$) in comparison with the *BALTIC2* master chronology and the individual series from panel P30 which includes two planks from the same altarpiece[5]. The weakness of the replication is explained by the lack of large numbers of *BALTIC2* type wood in the reference database for this period (in the following table, results are for $t > 3.5$).

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 92 | 0.43 | 0.60 | 5.66 | 1.0000 | 1317 | 1412 | BALTIC2 |
| 88 | 0.38 | 0.64 | 5.48 | 1.0000 | 1317 | 1412 | P30 |
| 92 | 0.38 | 0.39 | 3.97 | 0.9998 | 1317 | 1412 | P110 |
| 92 | 0.32 | 0.43 | 3.86 | 0.9998 | 1317 | 1412 | BALTIC0 |
| 92 | 0.30 | 0.45 | 3.80 | 0.9997 | 1317 | 1412 | P11 |
| 92 | 0.42 | 0.32 | 3.77 | 0.9997 | 1317 | 1412 | P208AC.ECH |
| 92 | 0.32 | 0.39 | 3.61 | 0.9996 | 1317 | 1412 | P134 |

[5] Plank XX-C and its pendant XI-A (plank sawn accross its thickness); to locate them on the altarpiece, see the schema in VYNCKIER 1999-2000, p. 238.

### 11.2.4. P464/02/2, central plank of *Saint John*

The sequence P464/02/2 yields excellent results: replication is good among the complete reference database since 35 chronologies give the result retained, **1073 – 1368**, with significant rates, among which half have a high synchronisation rate (with a maximum of $t = 7.65$).

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 151 | 0.58 | 0.48 | 7.65 | 1.0000 | 1250 | 1400 | BALTIC0 |
| 151 | 0.47 | 0.42 | 6.05 | 1.0000 | 1250 | 1400 | P208AC.ECH |
| 144 | 0.44 | 0.42 | 5.71 | 1.0000 | 1250 | 1400 | BALTIC2 |
| 151 | 0.43 | 0.39 | 5.50 | 1.0000 | 1250 | 1400 | P149AB.ECH |
| 149 | 0.40 | 0.38 | 5.09 | 1.0000 | 1250 | 1400 | P6 |
| 129 | 0.41 | 0.36 | 4.73 | 0.9999 | 1250 | 1400 | P47E |
| 151 | 0.41 | 0.31 | 4.66 | 0.9999 | 1250 | 1400 | P149C |
| 114 | 0.43 | 0.36 | 4.53 | 0.9999 | 1250 | 1400 | P225.DET |
| 151 | 0.34 | 0.35 | 4.47 | 0.9999 | 1250 | 1400 | P203AB-ech |
| 147 | 0.38 | 0.31 | 4.44 | 0.9999 | 1250 | 1400 | P130 |
| 151 | 0.30 | 0.36 | 4.32 | 0.9999 | 1250 | 1400 | P134 |
| 151 | 0.33 | 0.34 | 4.28 | 0.9999 | 1250 | 1400 | P204.ECH |
| 151 | 0.27 | 0.39 | 4.27 | 0.9999 | 1250 | 1400 | P195.ECH |
| 111 | 0.46 | 0.30 | 4.27 | 0.9999 | 1250 | 1400 | P47D |
| 143 | 0.29 | 0.38 | 4.21 | 0.9999 | 1250 | 1400 | P203CD-ech |
| 96 | 0.34 | 0.45 | 4.12 | 0.9999 | 1250 | 1400 | P192C.ECH |
| 130 | 0.34 | 0.34 | 4.05 | 0.9999 | 1250 | 1400 | P203E |

### 11.2.5. P464/03/2ab, right plank of *Saint John*

The series P464/03/2ab could be dated to **1207 – 1403** in particular by other planks in the altarpiece. In effect, while 13 chronologies from the complete reference database provide the result retained with significant synchronisation rates, all which have a Student's *t* greater than 4 come from the wing panels analysed by J. Vynckier: 7 of the 10 planks he identified yield high quality correlations[6].

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 149 | 0.50 | 0.39 | 6.02 | 1.0000 | 1207 | 1403 | P29 |
| 186 | 0.38 | 0.38 | 5.60 | 1.0000 | 1207 | 1403 | P26A |
| 194 | 0.38 | 0.32 | 5.16 | 1.0000 | 1207 | 1403 | P28C |
| 168 | 0.42 | 0.29 | 4.91 | 1.0000 | 1207 | 1403 | P22BEP. |
| 141 | 0.44 | 0.30 | 4.70 | 0.9999 | 1207 | 1403 | P25A |
| 182 | 0.30 | 0.31 | 4.32 | 0.9999 | 1207 | 1403 | P21-B |
| 187 | 0.35 | 0.22 | 4.07 | 0.9999 | 1207 | 1403 | P24 |

### 11.2.6. P465/01/1, left plank of the *Virgin Mary*

The tree-ring series P465/01/1 was able to be dated by its excellent correlation with another plank of the altarpiece analysed by J. Vynckier (P24, which combines planks XVI-A and VI-C[7]), a sign that these two planks come from the same tree. Without this relatedness, and in light of the other results, the position **1204 – 1406** would have been kept as a hypothetical proposal at best.

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 193 | 0.70 | 0.53 | 10.80 | 1.0000 | 1204 | 1406 | P24 |
| 203 | 0.32 | 0.32 | 4.79 | 1.0000 | 1204 | 1406 | P28C |
| 192 | 0.33 | 0.28 | 4.41 | 0.9999 | 1204 | 1406 | P26A |
| 203 | 0.27 | 0.27 | 4.01 | 0.9999 | 1204 | 1406 | P206.ECH |

[6] VYNCKIER 1999-2000.

[7] Being a plank of the *Virgin* in *grisaille* and its pendant on the panel of the *Angels Playing Music* (upper section of the altarpiece). VYNCKIER 1999-2000.

### 11.2.7. P465/02/1, central plank of the *Virgin Mary*

The dendrochronological sequence P465/02/1 gives very good results: replication is strong among the reference database chronologies that cover the region and period of this sequence, yielding the result retained, **1258 – 1408** (more than 45 chronologies from the reference database give the date retained with a significant Student's *t*), and the number of reference database chronologies that have high synchronisation rates ($t > 4$) is more than satisfactory.

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 151 | 0.48 | 0.47 | 6.52 | 1.0000 | 1258 | 1408 | BALTIC0 |
| 132 | 0.46 | 0.41 | 5.48 | 1.0000 | 1258 | 1408 | P10 |
| 148 | 0.42 | 0.33 | 4.88 | 1.0000 | 1258 | 1408 | P41 |
| 151 | 0.36 | 0.38 | 4.85 | 1.0000 | 1258 | 1408 | BALTIC2 |
| 114 | 0.43 | 0.40 | 4.82 | 0.9999 | 1258 | 1408 | P236B |
| 151 | 0.41 | 0.31 | 4.70 | 0.9999 | 1258 | 1408 | P207.ECH |
| 144 | 0.33 | 0.40 | 4.68 | 0.9999 | 1258 | 1408 | P243 |
| 151 | 0.45 | 0.26 | 4.66 | 0.9999 | 1258 | 1408 | P208AC.ECH |
| 145 | 0.40 | 0.31 | 4.56 | 0.9999 | 1258 | 1408 | P40 |
| 151 | 0.40 | 0.29 | 4.47 | 0.9999 | 1258 | 1408 | P137 |
| 151 | 0.37 | 0.31 | 4.38 | 0.9999 | 1258 | 1408 | P110 |
| 135 | 0.39 | 0.31 | 4.29 | 0.9999 | 1258 | 1408 | P113V |
| 141 | 0.39 | 0.28 | 4.22 | 0.9999 | 1258 | 1408 | P6 |
| 60 | 0.43 | 0.54 | 4.21 | 0.9999 | 1258 | 1408 | P217C |
| 98 | 0.41 | 0.35 | 4.00 | 0.9998 | 1258 | 1408 | P208B.ECH |

### 11.2.8. P465/03/1b, right plank of the *Virgin Mary*

The series P465/03/1b gives good results: replication is significant among the reference database chronologies covering the region and period of this sequence. More than 30 chronologies procure the result retained, **1233 – 1400**, with significant rates, among which half have high synchronisation rates.

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 143 | 0.51 | 0.36 | 5.76 | 1.0000 | 1233 | 1400 | P41 |
| 106 | 0.54 | 0.37 | 5.19 | 1.0000 | 1233 | 1400 | P236B |
| 168 | 0.39 | 0.35 | 5.14 | 1.0000 | 1233 | 1400 | BALTIC0 |
| 147 | 0.43 | 0.33 | 4.94 | 1.0000 | 1233 | 1400 | P130 |
| 168 | 0.37 | 0.35 | 4.92 | 1.0000 | 1233 | 1400 | P134 |
| 168 | 0.35 | 0.34 | 4.74 | 0.9999 | 1233 | 1400 | P40 |
| 157 | 0.38 | 0.30 | 4.52 | 0.9999 | 1233 | 1400 | P203AB-ech |
| 131 | 0.36 | 0.37 | 4.44 | 0.9999 | 1233 | 1400 | P47B |
| 152 | 0.40 | 0.28 | 4.40 | 0.9999 | 1233 | 1400 | P132 |
| 163 | 0.37 | 0.28 | 4.36 | 0.9999 | 1233 | 1400 | P26A |
| 168 | 0.39 | 0.25 | 4.33 | 0.9999 | 1233 | 1400 | P39 |
| 168 | 0.37 | 0.26 | 4.30 | 0.9999 | 1233 | 1400 | P207.ECH |
| 144 | 0.36 | 0.32 | 4.29 | 0.9999 | 1233 | 1400 | BALTIC2 |
| 145 | 0.36 | 0.31 | 4.25 | 0.9999 | 1233 | 1400 | P183AB |

11.2.9. P466/01/1, bottom plank of the *Adoration of the Lamb*

The sequence P466/01/1 gives results of excellent quality: replication is remarkable among the reference database chronologies covering the region and period of the sequence to be dated since 144 chronologies in the reference database give the result retained, **1147 – 1379**, with significant rates and many chronologies with very good results (13 chronologies have a Student's $t > 5$, with a maximum of 7.6).

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 233 | 0.43 | 0.52 | 7.60 | 1.0000 | 1147 | 1379 | BALTIC0 |
| 200 | 0.48 | 0.37 | 6.60 | 1.0000 | 1147 | 1379 | P134 |
| 207 | 0.46 | 0.37 | 6.42 | 1.0000 | 1147 | 1379 | P223A3.ECH |
| 216 | 0.42 | 0.40 | 6.37 | 1.0000 | 1147 | 1379 | P46D |
| 207 | 0.43 | 0.39 | 6.34 | 1.0000 | 1147 | 1379 | P123C |
| 233 | 0.43 | 0.38 | 6.29 | 1.0000 | 1147 | 1379 | P46B |
| 110 | 0.57 | 0.47 | 6.28 | 1.0000 | 1147 | 1379 | P226MB |
| 233 | 0.35 | 0.39 | 5.59 | 1.0000 | 1147 | 1379 | P149C |
| 149 | 0.48 | 0.32 | 5.28 | 1.0000 | 1147 | 1379 | P113P |
| 189 | 0.47 | 0.25 | 5.27 | 1.0000 | 1147 | 1379 | P39 |
| 135 | 0.48 | 0.34 | 5.18 | 1.0000 | 1147 | 1379 | P128A |
| 233 | 0.42 | 0.26 | 5.13 | 1.0000 | 1147 | 1379 | P137 |
| 182 | 0.42 | 0.28 | 5.01 | 1.0000 | 1147 | 1379 | P46C |
| 109 | 0.47 | 0.40 | 4.95 | 1.0000 | 1147 | 1379 | P237C |
| 136 | 0.43 | 0.35 | 4.88 | 1.0000 | 1147 | 1379 | P203AB-ech |
| 232 | 0.31 | 0.33 | 4.80 | 1.0000 | 1147 | 1379 | BALTIC1 |
| 121 | 0.60 | 0.21 | 4.78 | 0.9999 | 1147 | 1379 | P226MC |
| 193 | 0.37 | 0.29 | 4.76 | 0.9999 | 1147 | 1379 | HMC94 |
| 150 | 0.39 | 0.34 | 4.75 | 0.9999 | 1147 | 1379 | P11 |
| 139 | 0.38 | 0.37 | 4.73 | 0.9999 | 1147 | 1379 | P47H |
| 180 | 0.34 | 0.29 | 4.46 | 0.9999 | 1147 | 1379 | P47E |
| 207 | 0.21 | 0.37 | 4.29 | 0.9999 | 1147 | 1379 | P46A |
| 183 | 0.46 | 0.14 | 4.22 | 0.9999 | 1147 | 1379 | P206.ECH |
| 189 | 0.36 | 0.22 | 4.18 | 0.9999 | 1147 | 1379 | P139A |
| 145 | 0.55 | 0.11 | 4.15 | 0.9999 | 1147 | 1379 | P184B |
| 233 | 0.31 | 0.25 | 4.14 | 0.9999 | 1147 | 1379 | P208AC.ECH |
| 204 | 0.27 | 0.29 | 4.12 | 0.9999 | 1147 | 1379 | P223A1.ECH |
| 104 | 0.36 | 0.39 | 4.11 | 0.9999 | 1147 | 1379 | P123D |
| 184 | 0.34 | 0.24 | 4.11 | 0.9999 | 1147 | 1379 | P28C |
| 105 | 0.36 | 0.39 | 4.07 | 0.9999 | 1147 | 1379 | P178 |
| 233 | 0.26 | 0.29 | 4.06 | 0.9999 | 1147 | 1379 | P209.ECH |

11.2.10. P466-03-ech, 3rd plank from the bottom of the *Adoration of the Lamb*

The dendrochronological sequence P466-03-ech gives very good results: replication is strong among the reference database chronologies covering the region and period of the sequence to be dated since more than 50 chronologies procure the result retained, **1038 – 1394**, and nearly half of these synchronisation rates are greater than 4.

| Length covered | Cor1 | Cor2 | *Student's t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 147 | 0.45 | 0.42 | 5.80 | 1.0000 | 1038 | 1394 | P211B |
| 205 | 0.37 | 0.33 | 5.26 | 1.0000 | 1038 | 1394 | P138 |
| 182 | 0.37 | 0.33 | 5.02 | 1.0000 | 1038 | 1394 | P207.ECH |
| 247 | 0.37 | 0.29 | 4.95 | 1.0000 | 1038 | 1394 | BALTIC1 |
| 222 | 0.38 | 0.27 | 4.91 | 1.0000 | 1038 | 1394 | P123C |
| 343 | 0.35 | 0.30 | 4.86 | 1.0000 | 1038 | 1394 | BALTIC0 |
| 176 | 0.46 | 0.21 | 4.70 | 0.9999 | 1038 | 1394 | P133 |
| 195 | 0.33 | 0.30 | 4.58 | 0.9999 | 1038 | 1394 | P199ABC.ECH |
| 219 | 0.31 | 0.30 | 4.57 | 0.9999 | 1038 | 1394 | P223A1.ECH |
| 180 | 0.31 | 0.33 | 4.54 | 0.9999 | 1038 | 1394 | P47E |
| 136 | 0.37 | 0.35 | 4.43 | 0.9999 | 1038 | 1394 | P226MC |
| 198 | 0.32 | 0.28 | 4.41 | 0.9999 | 1038 | 1394 | P206.ECH |
| 231 | 0.27 | 0.32 | 4.39 | 0.9999 | 1038 | 1394 | P46D |
| 172 | 0.28 | 0.35 | 4.30 | 0.9999 | 1038 | 1394 | P205.ECH |
| 357 | 0.34 | 0.24 | 4.27 | 0.9999 | 1038 | 1394 | P149C |
| 175 | 0.33 | 0.28 | 4.26 | 0.9999 | 1038 | 1394 | P47C |
| 204 | 0.34 | 0.23 | 4.20 | 0.9999 | 1038 | 1394 | P39 |
| 140 | 0.43 | 0.24 | 4.18 | 0.9999 | 1038 | 1394 | P113B |
| 215 | 0.34 | 0.23 | 4.18 | 0.9999 | 1038 | 1394 | P134 |
| 69 | 0.45 | 0.45 | 4.17 | 0.9999 | 1038 | 1394 | P223CBE |
| 150 | 0.33 | 0.32 | 4.14 | 0.9999 | 1038 | 1394 | P128A |
| 67 | 0.44 | 0.47 | 4.13 | 0.9999 | 1038 | 1394 | P53B |
| 193 | 0.28 | 0.29 | 4.09 | 0.9999 | 1038 | 1394 | P243 |

11.2.11. P466/04/1, top plank of the *Adoration of the Lamb*

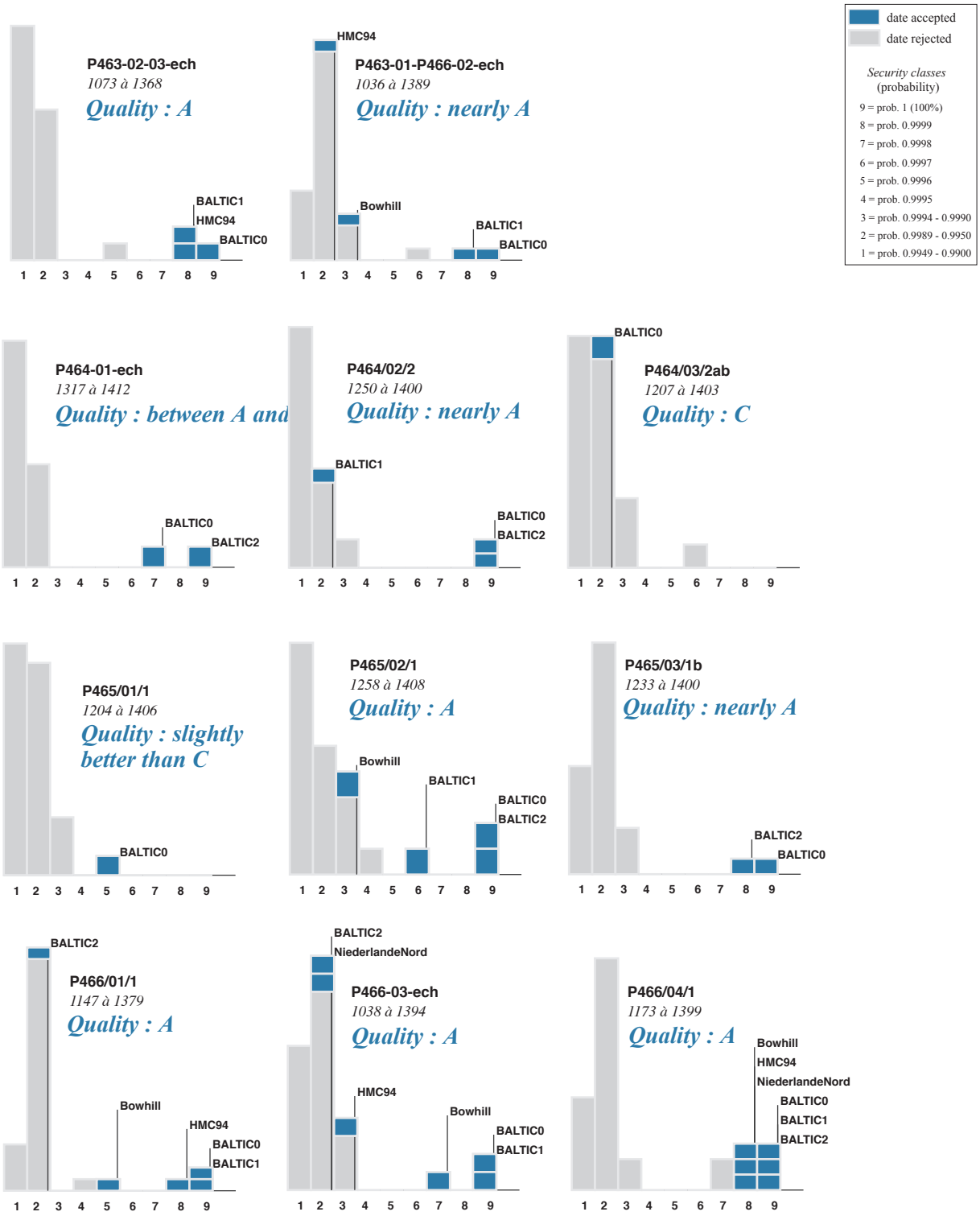
The series P466/04/1 yields exceptional results: replication is very strong among the reference database chronologies since more than 75 chronologies covering the region and period of this series give the result retained, **1173 – 1399**, with significant synchronisation rates; moreover, a remarkable number of these results are very high (18 chronologies have a Student's $t > 5$, with a maximum of 9.65)[8].

| Length covered | Cor1 | Cor2 | Student's *t* | Probability/ security | First ring | Last ring | Reference chronology |
|---|---|---|---|---|---|---|---|
| 226 | 0.59 | 0.54 | 9.65 | 1.0000 | 1173 | 1399 | P149C |
| 226 | 0.57 | 0.42 | 8.04 | 1.0000 | 1173 | 1399 | P149AB.ECH |
| 155 | 0.56 | 0.42 | 6.93 | 1.0000 | 1173 | 1399 | P203AB-ech |
| 226 | 0.46 | 0.41 | 6.79 | 1.0000 | 1173 | 1399 | BALTIC0 |
| 219 | 0.56 | 0.30 | 6.75 | 1.0000 | 1173 | 1399 | P134 |
| 201 | 0.33 | 0.48 | 6.32 | 1.0000 | 1173 | 1399 | P46C |
| 226 | 0.46 | 0.35 | 6.25 | 1.0000 | 1173 | 1399 | P30 |
| 204 | 0.46 | 0.35 | 6.23 | 1.0000 | 1173 | 1399 | P40 |
| 226 | 0.50 | 0.29 | 6.13 | 1.0000 | 1173 | 1399 | P223A3.ECH |
| 226 | 0.43 | 0.34 | 5.95 | 1.0000 | 1173 | 1399 | P123C |
| 208 | 0.45 | 0.31 | 5.79 | 1.0000 | 1173 | 1399 | P39 |
| 209 | 0.43 | 0.30 | 5.54 | 1.0000 | 1173 | 1399 | P138 |
| 131 | 0.43 | 0.42 | 5.33 | 1.0000 | 1173 | 1399 | P47H |
| 226 | 0.40 | 0.29 | 5.25 | 1.0000 | 1173 | 1399 | P208AC.ECH |
| 220 | 0.35 | 0.34 | 5.21 | 1.0000 | 1173 | 1399 | P203CD-ech |
| 226 | 0.30 | 0.38 | 5.12 | 1.0000 | 1173 | 1399 | P137 |
| 168 | 0.43 | 0.29 | 5.04 | 1.0000 | 1173 | 1399 | P113P |
| 186 | 0.34 | 0.36 | 5.04 | 1.0000 | 1173 | 1399 | P207.ECH |
| 226 | 0.46 | 0.20 | 4.98 | 1.0000 | 1173 | 1399 | BALTIC1 |
| 197 | 0.36 | 0.31 | 4.96 | 1.0000 | 1173 | 1399 | P243 |
| 195 | 0.39 | 0.28 | 4.89 | 1.0000 | 1173 | 1399 | P114B122.ECH |
| 142 | 0.36 | 0.39 | 4.84 | 1.0000 | 1173 | 1399 | BALTIC2 |
| 142 | 0.41 | 0.34 | 4.81 | 0.9999 | 1173 | 1399 | P216B |
| 175 | 0.36 | 0.31 | 4.73 | 0.9999 | 1173 | 1399 | P223A2.ECH |
| 226 | 0.33 | 0.30 | 4.71 | 0.9999 | 1173 | 1399 | P113L |
| 200 | 0.43 | 0.21 | 4.71 | 0.9999 | 1173 | 1399 | NiederlandeNord |
| 226 | 0.43 | 0.20 | 4.68 | 0.9999 | 1173 | 1399 | Bowhill |
| 167 | 0.34 | 0.34 | 4.67 | 0.9999 | 1173 | 1399 | HMC94 |
| 164 | 0.45 | 0.23 | 4.61 | 0.9999 | 1173 | 1399 | P184B |
| 180 | 0.43 | 0.22 | 4.56 | 0.9999 | 1173 | 1399 | P133 |
| 180 | 0.44 | 0.20 | 4.53 | 0.9999 | 1173 | 1399 | P47E |
| 219 | 0.27 | 0.34 | 4.49 | 0.9999 | 1173 | 1399 | P21-B |
| 128 | 0.33 | 0.41 | 4.42 | 0.9999 | 1173 | 1399 | P203E |
| 187 | 0.41 | 0.21 | 4.41 | 0.9999 | 1173 | 1399 | P154 |
| 195 | 0.44 | 0.16 | 4.40 | 0.9999 | 1173 | 1399 | P199ABC.ECH |
| 226 | 0.22 | 0.37 | 4.40 | 0.9999 | 1173 | 1399 | P46A |
| 129 | 0.45 | 0.27 | 4.37 | 0.9999 | 1173 | 1399 | P117 |
| 203 | 0.34 | 0.24 | 4.27 | 0.9999 | 1173 | 1399 | P131 |
| 201 | 0.36 | 0.21 | 4.22 | 0.9999 | 1173 | 1399 | P126 |
| 208 | 0.40 | 0.16 | 4.16 | 0.9999 | 1173 | 1399 | P139A |
| 144 | 0.40 | 0.26 | 4.15 | 0.9999 | 1173 | 1399 | P113B |
| 168 | 0.29 | 0.32 | 4.14 | 0.9999 | 1173 | 1399 | P195.ECH |
| 150 | 0.45 | 0.19 | 4.10 | 0.9999 | 1173 | 1399 | P132 |
| 101 | 0.42 | 0.34 | 4.08 | 0.9999 | 1173 | 1399 | P27C |
| 143 | 0.37 | 0.28 | 4.04 | 0.9999 | 1173 | 1399 | P183AB |

[8] Synchronisation rates greater than 9 may be obtained on planks from the same tree, although this is not the case here: P466/04/1 likely does not come from the same trunk as the reference database chronology providing this extremely high value (P149C), which is a plank from a painting by Petrus Christus (Tab. 11.5.11).

11.3. *P distributions* or *combined Girardclos diagrams*[62] for the chronological positions proposed by *Dendron II* when calculating the 11 chronologies representative of the 11 trees identified for the central panels, using the regional and site chronologies of the reference database that cover their period[63]

See appendix "Interpretation of graphic illustrations of the results produced by the *Dendron II* system" at the end of the report, explaining the quality of results obtained in the diagrams (excellent *A* ; acceptable *B* ; mediocre *C*).

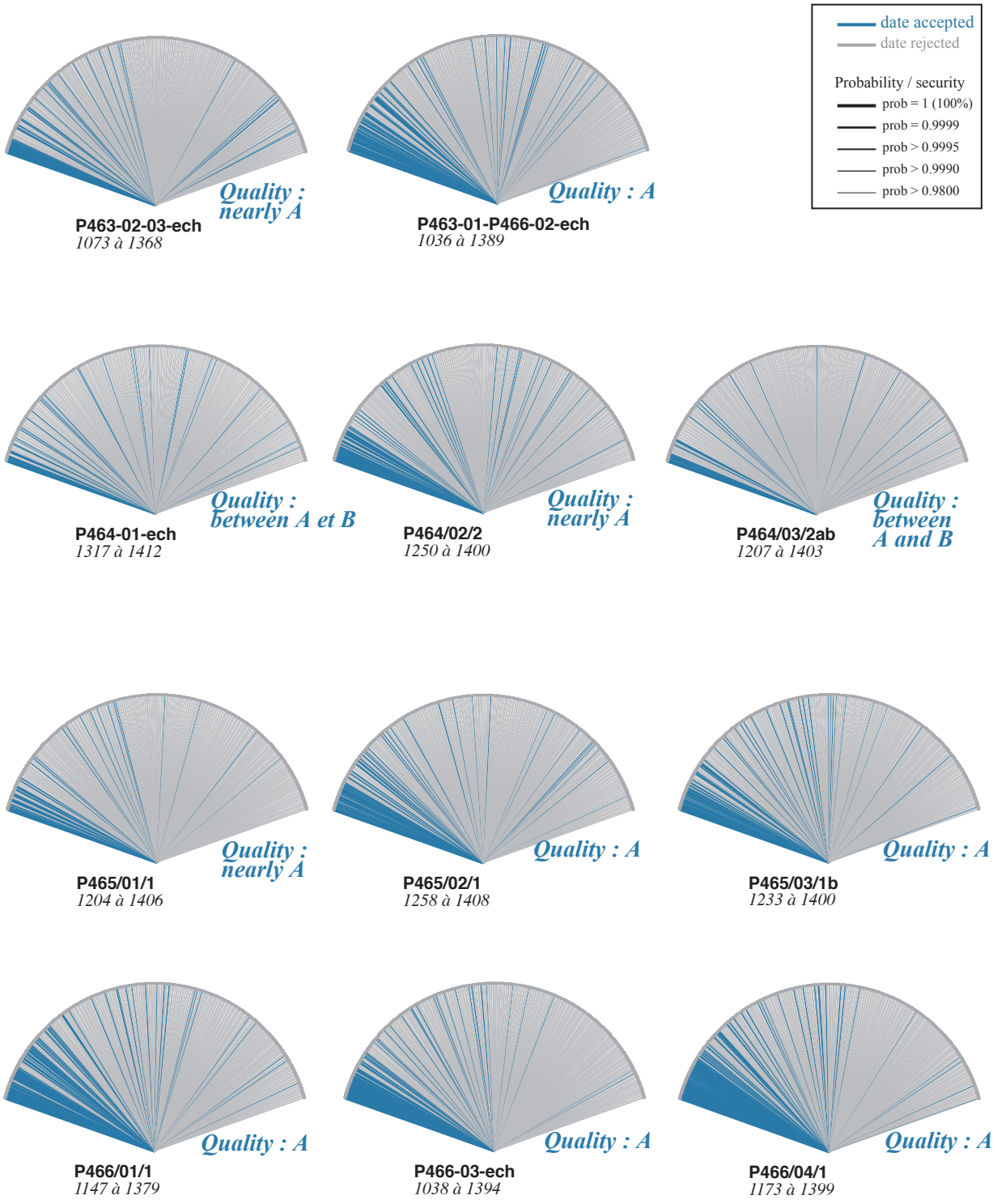



[62] The principle of *P distributions* is derived from Girardclos 1999. The concept of combining the diagrams is due to Lambert 2006; these are produced by the *Dendron II* program.

[63] The Baltic chronologies that cover the period of the altarpiece are *BALTIC1* and *BALTIC2* (Hillam & Tyers 1995), *BALTIC0* (Tyers, unpublished), *Bowhill* (Groves 2004), *HMC 94* (Groves & Tyers, unpublished) and *NiederlandeNord* (Klein, unpublished).

11.4. *Correlation fans*[64] of the chronological positions proposed by *Dendron II* for calculation of the 11 chronologies representative of the 11 trees identified for the central panels, using individual reference chronologies, for the period and region covered by the woods to be dated[65]

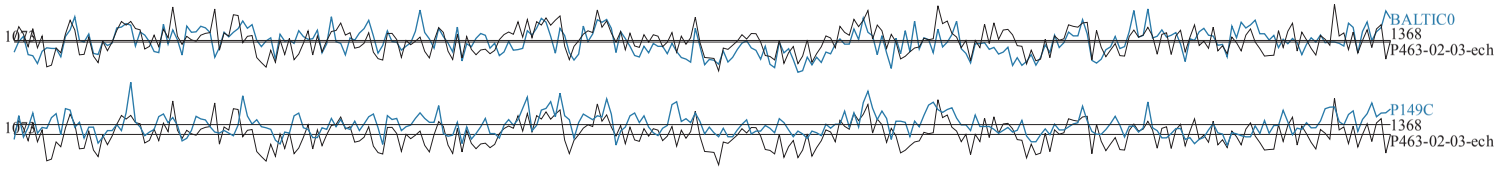
See appendix "Interpretation of graphic illustrations of the results produced by the *Dendron II* system" at the end of the report, explaining the quality of results obtained in the diagrams (excellent *A* ; acceptable *B* ; mediocre *C*).



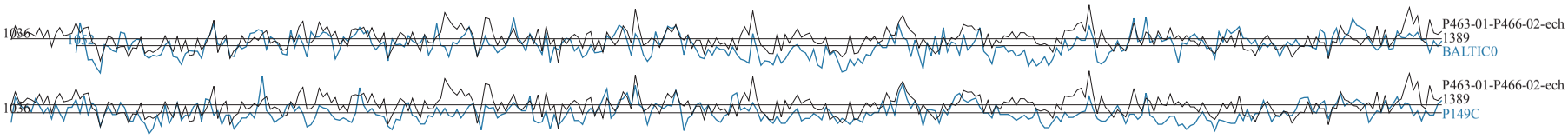

[64] The principle of illustrating *correlation fans* is due to Lambert 2006; these are produced by the *Dendron II* program.
[65] The fans are drawn on the basis of a selection of 95 individual "Baltic" sequence from painted panels that cover the period of the woods to be dated; these were constructed by J. Vynckier and P. Fraiture. Ref. *JVk/PaF_2008(KIK_IRPA)*.

11.5.Verification of the dates of the 11 chronologies representative of the 11 trees identified for the central panels, through visual comparison with reference chronologies (in blue). The quality of the synchronisations obtained ensures the chronological position retained for each wood

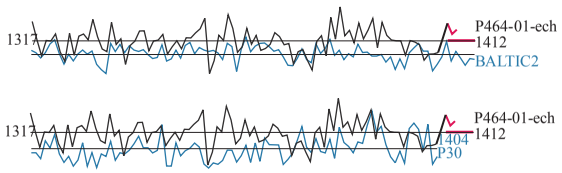
11.5.1. P463-02-03-ech, dendrochronological mean for the right and central planks of *God the Father*, compared with the regional chronology *BALTIC0* (Tyers, unpublished) and the individual chronology of panel P149C (Vynckier & Fraiture, unpublished).



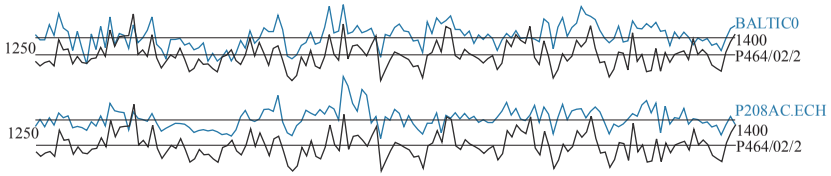

11.5.2. P463-01-P466-02-ech, dendrochronological mean for the left plank of *God the Father* and the 2nd plank from the bottom of the *Adoration of the Lamb*, compared with the regional chronology *BALTIC0* (Tyers, unpublished) and the individual chronology of panel P149C (Vynckier & Fraiture, unpublished).



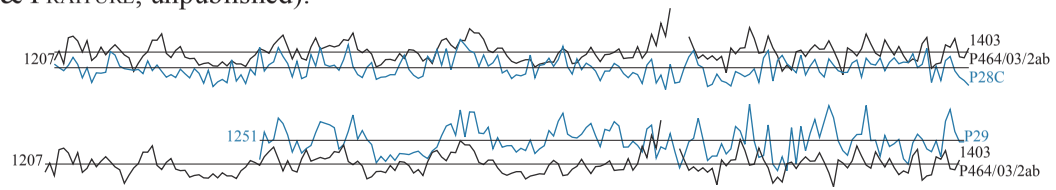

11.5.3. P464-01-ech, dendrochronological sequence for the left plank of *Saint John*, compared with the regional chronology *BALTIC2* (Hillam & Tyers 1995) and the individual chronology P30, from the same altarpiece (Vynckier & Fraiture, unpublished). Sapwood represented in red.



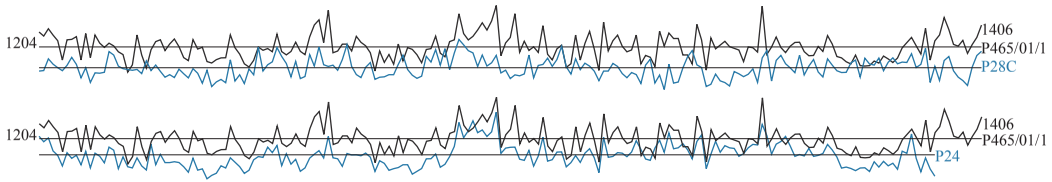
11.5.4. P464/02/2, dendrochronological sequence for the central plank of *Saint John*, compared with the regional chronology *BALTIC0* (Tyers, unpublished) and the individual chronology of panel P208AC.ECH (Vynckier & Fraiture, unpublished).



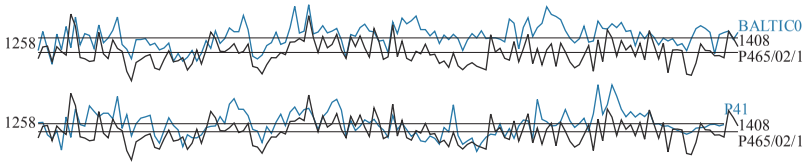

11.5.5. P464/03/2ab, dendrochronological sequence for the right plank of *Saint John*, compared with individual chronologies of two panels, P28C and P29, from the same altarpiece (Vynckier & Fraiture, unpublished).



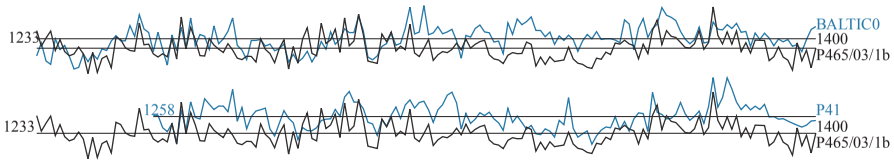

11.5.6. P465/01/1, dendrochronological sequence for the left plank of the *Virgin Mary,* compared with individual chronologies of two panels, P28C and P24, from the same altarpiece (Vynckier & Fraiture, unpublished). The remarkable similarity between P465/01/1 and P24 indicates that these planks come from the same oak.



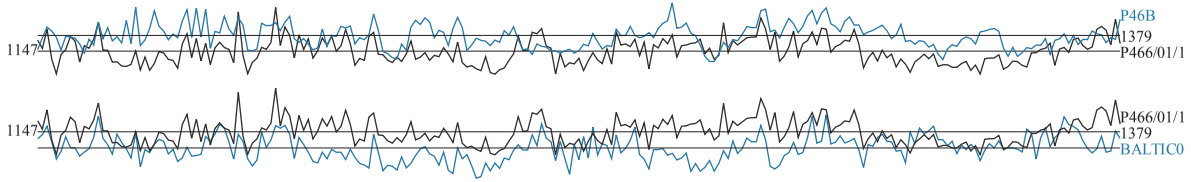

11.5.7. P465/02/1, dendrochronological sequence for the central plank of the *Virgin Mary*, compared with the regional chronology *BALTIC0* (Tyers, unpublished) and the individual chronology of panel P41 (Vynckier & Fraiture, unpublished).



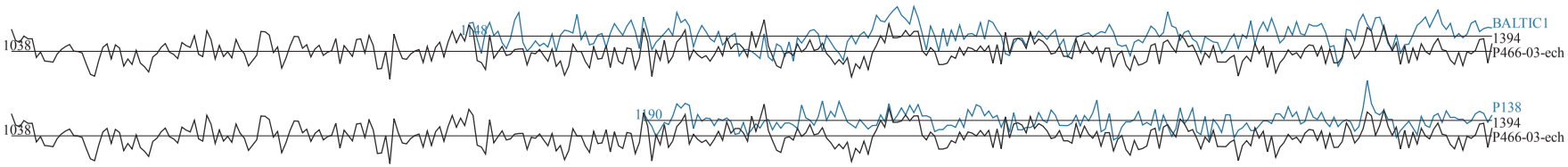
11.5.8. P465/03/1b, dendrochronological sequence for the right plank of the *Virgin Mary*, compared with the regional chronology *BALTIC0* (Tyers, unpublished) and the individual chronology of panel P41 (Vynckier & Fraiture, unpublished).



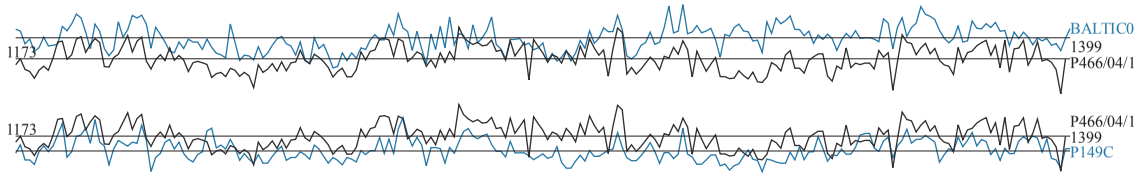

11.5.9. P466/01/1, dendrochronological sequence for the bottom plank of the *Adoration of the Lamb*, compared with the regional chronology *BALTIC0* (Tyers, unpublished) and the individual chronology of panel P46B (Vynckier & Fraiture, unpublished).




11.5.10. P466-03-ech, dendrochronological sequence for the 3rd plank from the bottom of the *Adoration of the Lamb,* compared with the regional chronology *BALTIC1* (Hillam & Tyers 1995) and the individual chronology of panel P138 (Vynckier & Fraiture, unpublished).

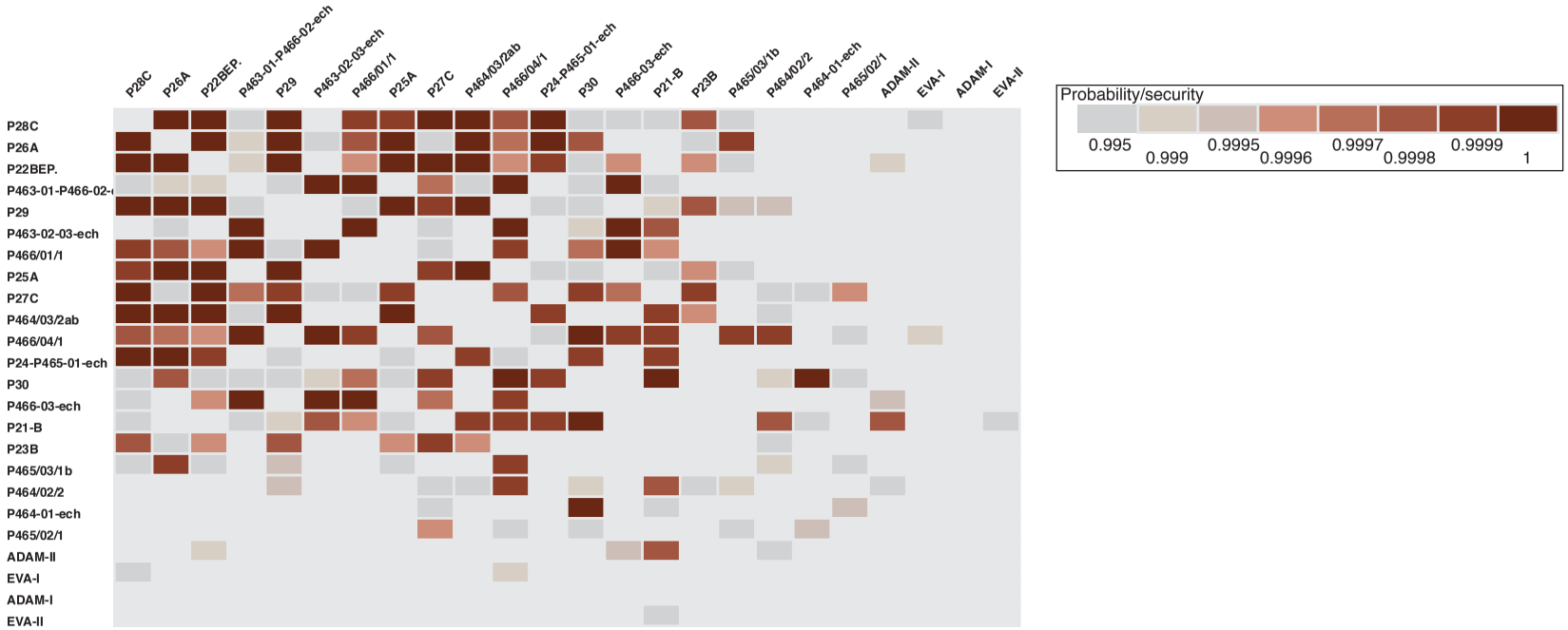



11.5.11. P466/04/1, dendrochronological sequence for the top plank of the *Adoration of the Lamb*, compared with the regional chronology *BALTIC0* (Tyers, unpublished) and the individual chronology of panel P149C (Vynckier & Fraiture, unpublished).



## 11.6. Graphics covering all of the dated planks of the altarpiece

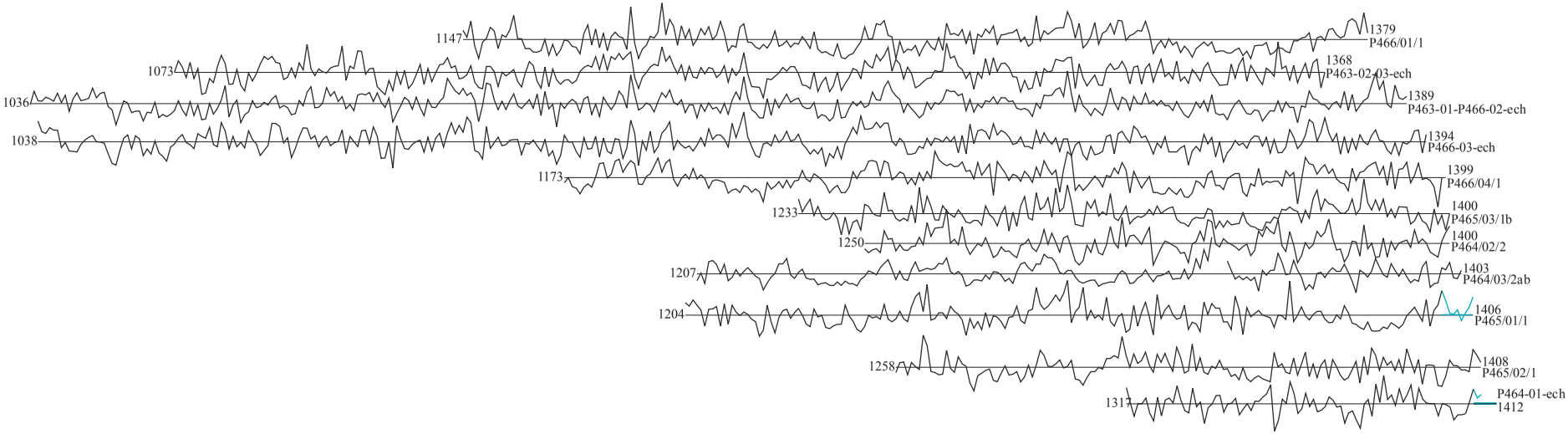
### 11.6.1. Square correlation matrix of all dated planks of the altarpiece



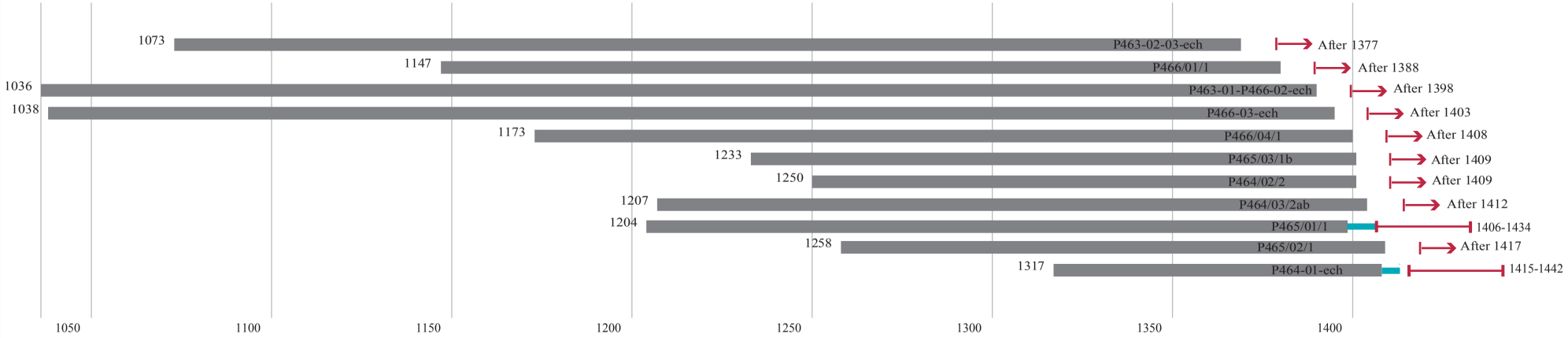

The *square correlation matrix* of all planks of the altarpiece shows, in a single view, the quality of the synchronisations obtained between the planks. In this kind of matrix (called "square correlation matrix of the fourth"[66]), a classification unique to the *Dendron II* program was carried out in order to group the planks with the best synchronisations with others in the group in the top left corner (the darker the cell, the better the results), the less good being relegated to the lower right corner. This matrix thus accounts for good homogeneity of the planks used in the altarpiece, since the majority correlate well with the other planks. The series of rings found at the end of the matrix, that is, those which yield no synchronisation or poor quality synchronisation in the altarpiece are – except for three series from *Adam* and *Eve*, analysed by P. Klein, which did not provide a valid synchronisation – *Adam* II, P465/02/1 and P464-01-ech. *Adam* II having been constructed by P. Klein, it is not discussed here. The 'poor' position of P464-01-ech (left plank of *Saint John*) is readily explained by its growth profile, different from all of the others (see point 5, p. 8). P465/02/1 (central plank of the *Virgin Mary*) is slightly differentiated from the others, given its place in the matrix. This does not, however, affect its dating, which is supported by chronologies external to the present altarpiece (see table in point 11.2.7). This matrix alone justifies the dates proposed for all of the planks from the central panels, the least favourable cases of P464-01-ech and P465/02/1 having already been discussed.

[66] This kind of matrix is automatically produced by *Dendron II* (Lambert 2006).

11.6.2. Synchronisation between the 11 chronologies representative of the 11 trees identified for the central panels. The majority of the sequences are well correlated, with the exception of P464-01-ech and P465/02/1 (see point 11.6.1).




11.6.3. Dendrochronological bar-diagram for the 11 chronologies representative of the 11 trees identified for the central panels. The estimation for felling for each wood is given based on the minimum and, in two cases, also on the maximum number of rings that should contain sapwood for these "Baltic" oaks.

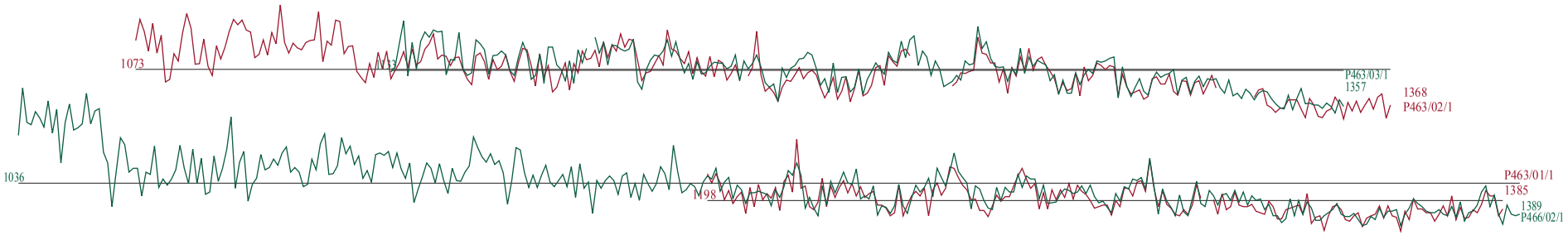


11.7. Table and graphics demonstrating the common origin (same tree) for two pairs of planks found in the central panels of the altarpiece: the first pair including P466/02 and P463/01 (a plank from the *Adoration of the Lamb* and a plank from *God the Father*) and the second pair including P463/02 and P463/03 (two planks from *God the Father*)

11.7.1. Square correlation matrix obtained between the dendrochronological sequences of the 13 planks that form the four central panels. The synchronisation rates obtained, between P466/02 and P463/01 on one hand, and between P463/02 and P463/03 on the other, are extremely high ($t > 9.8$).

| | P466/02 | P463/01 | P463/02 | P463/03 | P466/01 | P466/03 | P466/04 | P464/03 | P465/03 | P464/02 | P465/02 | P465/01 | P464/01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P466/02 | | 10.37 | 7.75 | 7.77 | 7.81 | 6.28 | 5.85 | 3.12 | | | | | |
| P463/01 | 10.37 | | 7.06 | 7.21 | 6.49 | 6.76 | 5.54 | 3.55 | | 1.74 | 2.28 | 3.06 | |
| P463/02 | 7.75 | 7.06 | | 9.82 | 7.49 | 4.96 | 4.7 | | 1.87 | 1.81 | 1.58 | | |
| P463/03 | 7.77 | 7.21 | 9.82 | | 6.43 | 5 | 4.59 | | 2.05 | 2.26 | 1.22 | 1.48 | |
| P466/01 | 7.81 | 6.49 | 7.49 | 6.43 | | 5.88 | 4.33 | 2.35 | | 2.07 | | 1.79 | |
| P466/03 | 6.28 | 6.76 | 4.96 | 5 | 5.88 | | 4.41 | 1.83 | | 1.73 | | 2.93 | |
| P466/04 | 5.85 | 5.54 | 4.7 | 4.59 | 4.33 | 4.41 | | | 4.62 | 4.39 | 2.92 | | 1.83 |
| P464/03 | 3.12 | 3.55 | | | 2.35 | 1.83 | | | 2.24 | 3.08 | | 3.97 | |
| P465/03 | | | 1.87 | 2.05 | | | 4.62 | 2.24 | | 3.38 | 3.17 | | 2.25 |
| P464/02 | | 1.74 | 1.81 | 2.26 | 2.07 | 1.73 | 4.39 | 3.08 | 3.38 | | 2.45 | | 1.35 |
| P465/02 | | 2.28 | 1.58 | 1.22 | | | 2.92 | | 3.17 | 2.45 | | | 3.5 |
| P465/01 | | 3.06 | | 1.48 | 1.79 | 2.93 | | 3.97 | | | | | |
| P464/01 | | | | | | | 1.83 | | 2.25 | 1.35 | 3.5 | | |

11.7.2. Visual synchronisations between the dendrochronological sequences of the two pairs of planks considered as coming from the same tree. In both cases, the graphics are remarkably similar.



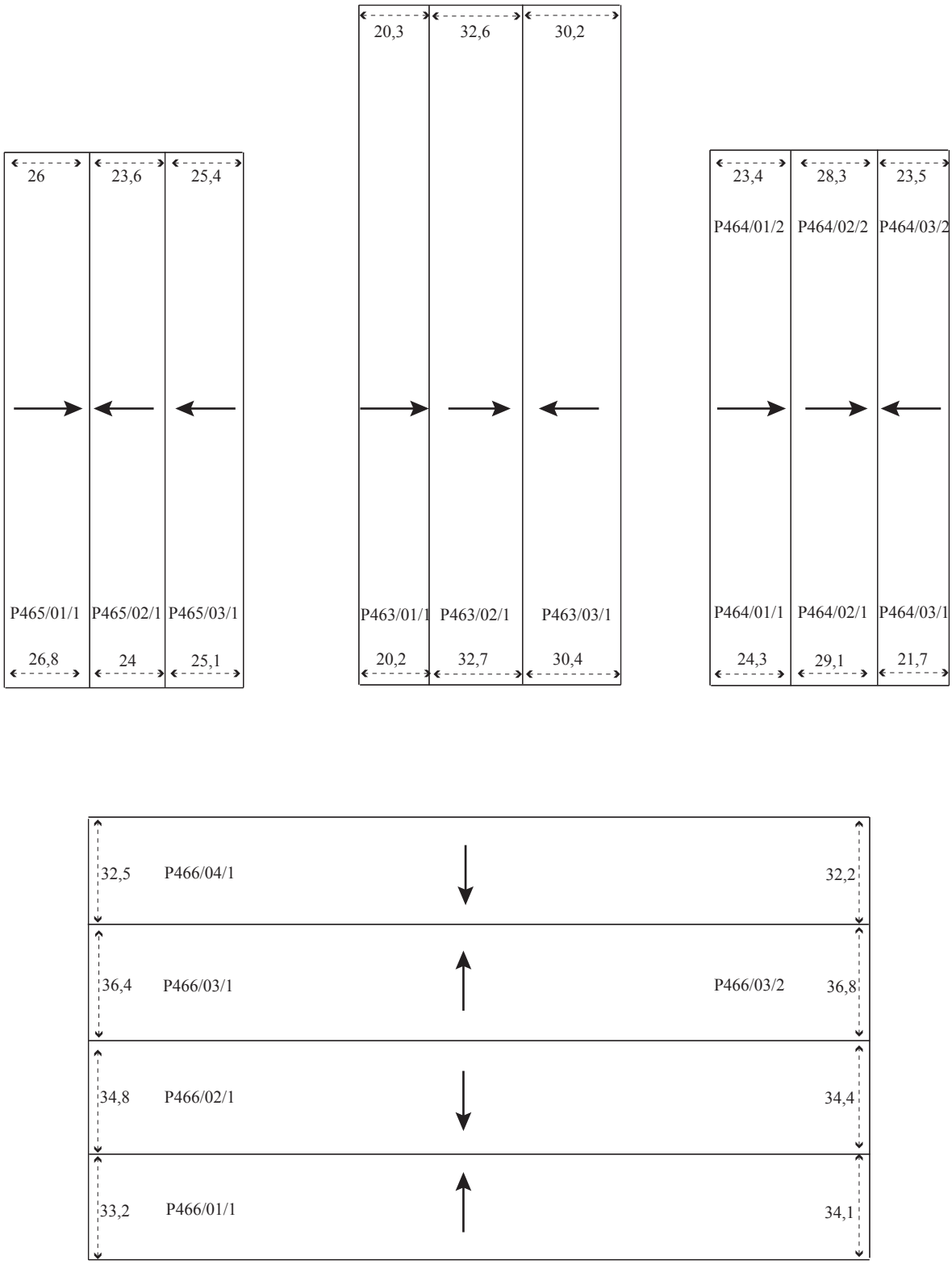



Fig. 1. Schemas for the central panels of the altarpiece (from the front) with notation of the dendrochronological identification codes. Measurements are given in cm. Arrows indicate the direction of ring growth, from the pith toward the sapwood. © P. Fraiture (IRPA/KIK)

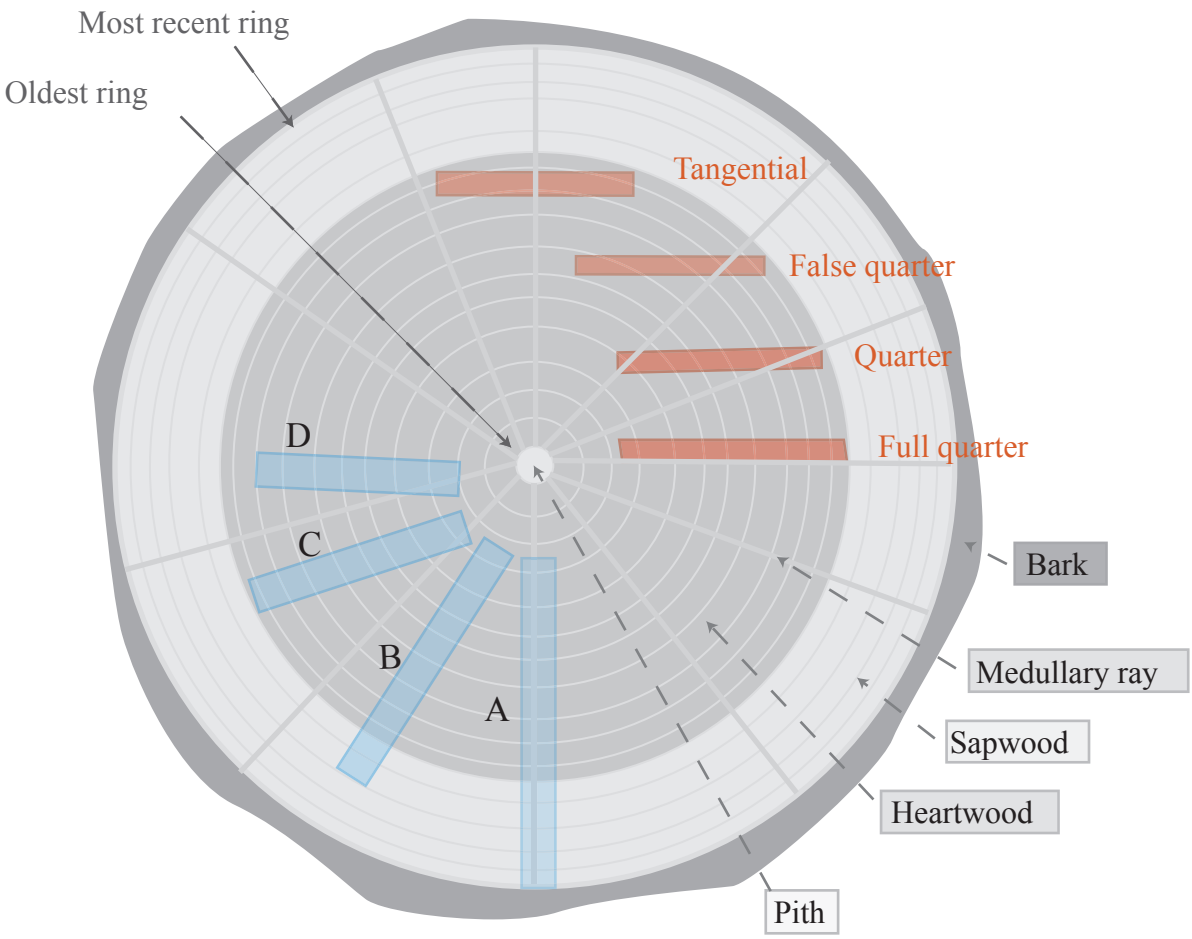



Fig. 2. Schema of the transversal section of an oak trunk showing:
- the different parts of the tree: pith, heartwood, sapwood and medullary rays (and bark covering the trunk);
- the succession of annual growth rings, the oldest surrounding the pith and the most recent formed on the periphery of the trunk, just below the bark;
- the different orientations for splitting planks (in red): full radial, radial, semi-radial, and tangential;
- the different possible situations influencing the interpretation of the felling date of the tree (in blue): plank with complete sapwood (A), plank with partial sapwood (B), planks without sapwood (only sapwood is missing in case C; all sapwood and some heartwood rings are missing in case D).
© P. Fraiture (IRPA/KIK)

Fig. 3. Panel of the *Adoration of the Lamb*, bottom plank (P466/01) © P. Fraiture (IRPA/KIK)

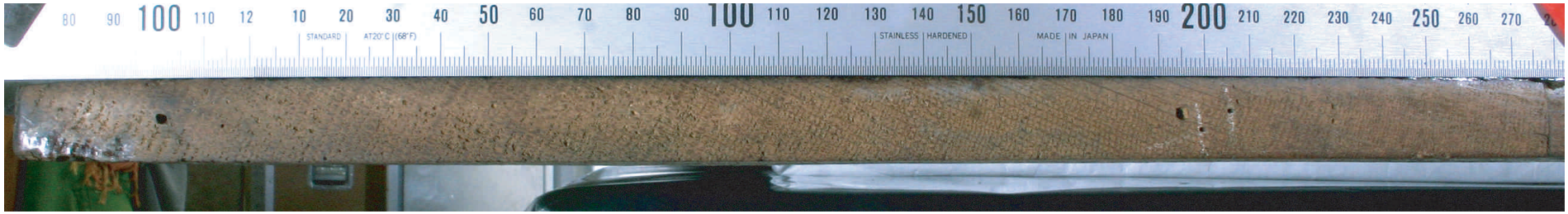



Fig. 3a. Left edge, complete view before preparation. The medullary rays are slightly sinuous, in particular at the end of growth (on right).

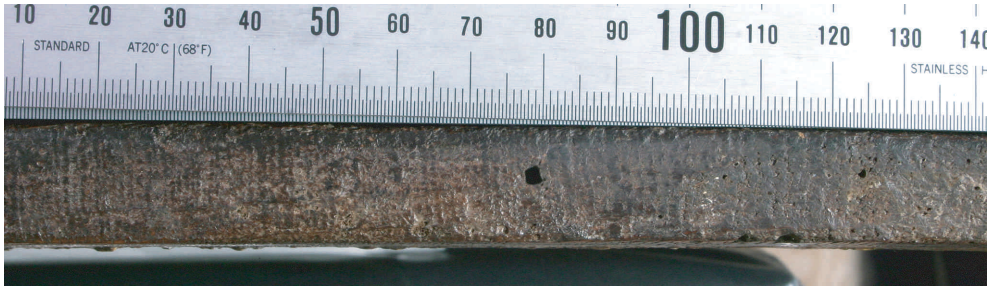



Fig. 3b. Right edge, detail (without preparation). Full quarter cutting.

Fig. 3c. Left edge, two details after preparation by brushing. Quarter cutting. On the left, beginning of growth, slow (narrow rings); on the right, end of growth, very slow (extremely narrow rings).

Fig. 4. Panel of the *Adoration of the Lamb*, 2nd plank from the bottom (P466/02) © P. Fraiture (IRPA/KIK)

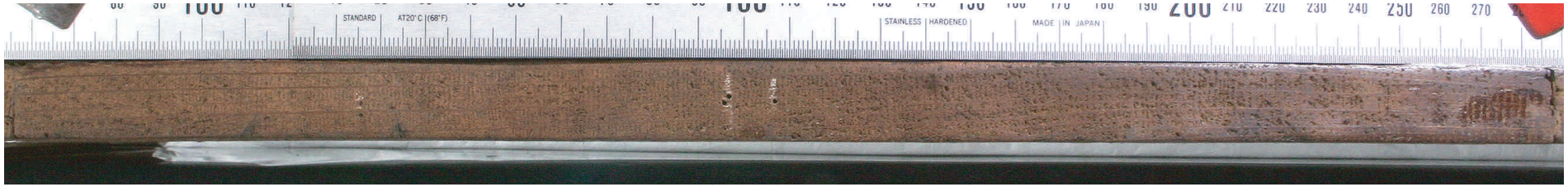



Fig. 4a. Left edge, complete view before preparation. The medullary rays are slightly sinuous.

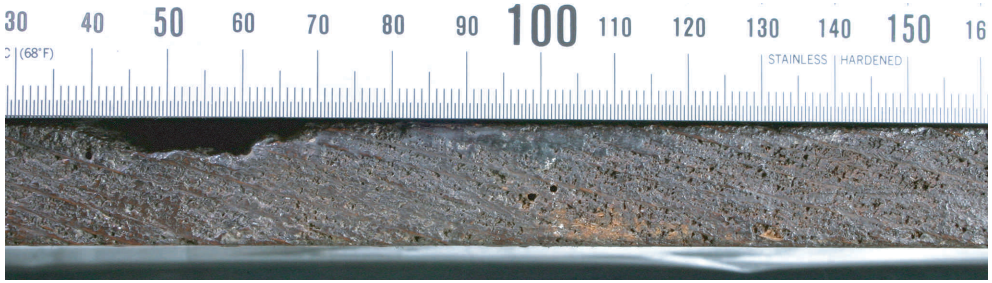



Fig. 4b. Right edge, detail (without preparation). Quarter cutting. Surface of the plank more irregular than on the other edge (Fig. 4a).

Fig. 4c. Left edge, two details after preparation (laser on the left; brush on the right). Full quarter cutting. On the left, beginning of growth with medium growth rythm that slows; on the right, end of growth, very slow (extremely narrow rings).

Fig. 5. Panel of the *Adoration of the Lamb*, 3rd plank from the bottom (P466/03) © P. Fraiture (IRPA/KIK)

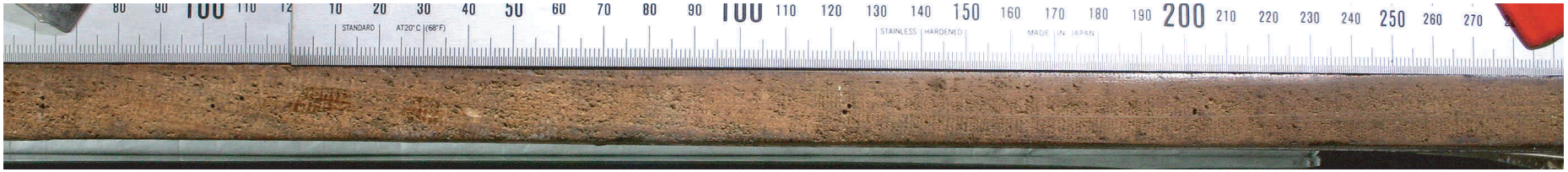



Fig. 5a. Left edge, complete view (before preparation). The medullary rays are slightly curved.

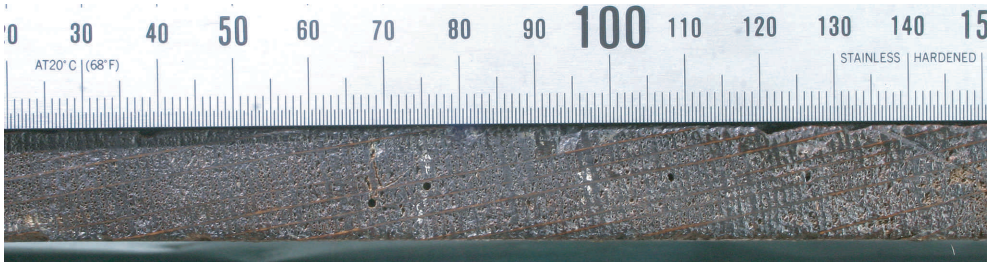



Fig. 5b. Right edge, detail (without preparation). Quarter cutting.

Fig. 5c. Left edge, two details after preparation (laser and brush on the left, brush on the right). Full quarter cutting. Very slow growth. On the right, joint with the top plank (P466/04).

Fig. 6. Panel of the *Adoration of the Lamb*, top plank (P466/04) © P. Fraiture (IRPA/KIK)

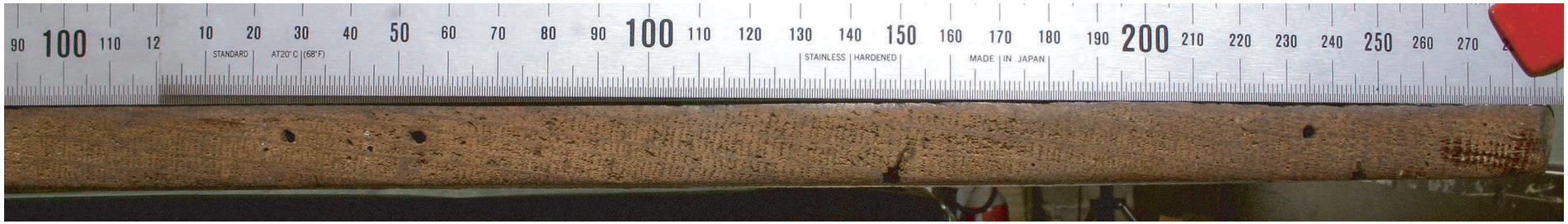



Fig. 6a. Left edge, complete view (before preparation). Medullary rays are slightly sinuous.

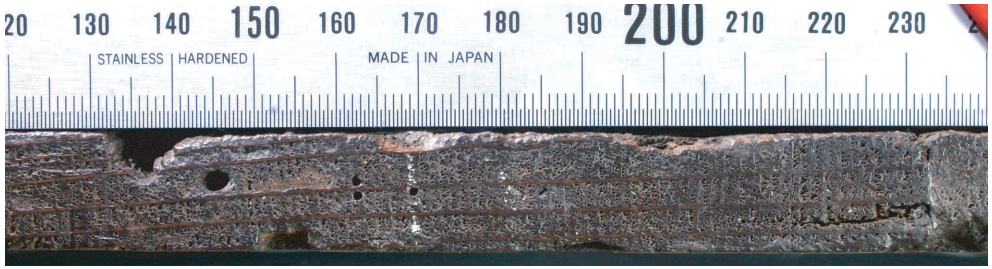



Fig. 6b. Right edge, detail (without preparation). Full quarter cutting but medullary rays slightly curved. Wood damaged.

Fig. 6c. Left edge, two details after preparation (brush only). Quarter cutting. Relatively rapid growth at the start (on left) and slow at the end. Also on the right, some slight damage to the wood, which, however, does not cause problems in measurement given the thickness of the plank.

Fig. 7. Panel of *God the Father*, left plank (P463/01) © P. Fraiture (IRPA/KIK)

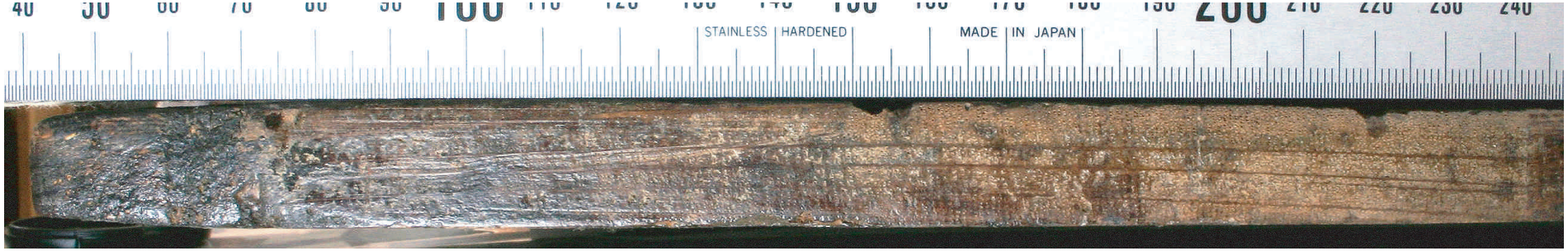



Fig. 7a. Lower edge, complete view (before preparation). Medullary rays slightly curved.


Fig. 7b. Upper edge, complete view (without preparation). Quarter cutting and medullary rays very slightly curved. Surface of the plank more irregular than on the other edge (Fig. 7a).

Fig. 7c. Lower edge, two details after preparation (cutter, partially, and brush). Full quarter cutting. Very slow growth from the start (on left), and slowing even more at the end of the sequence (on right).

Fig. 8. Panel of *God the Father*, central plank (P463/02) © P. Fraiture (IRPA/KIK)

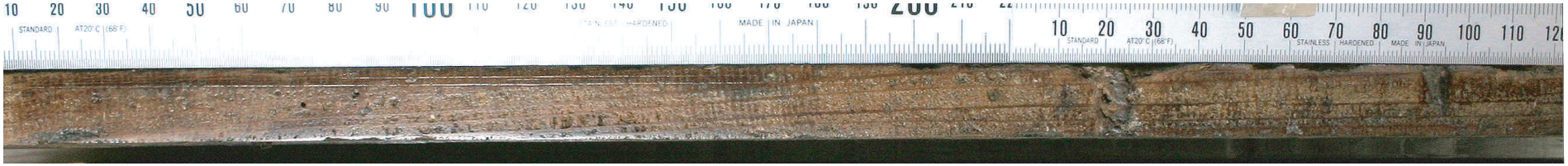
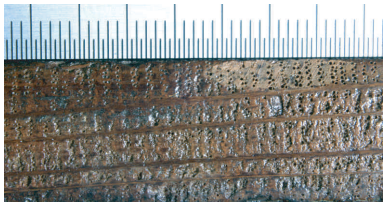



Fig. 8a. Lower edge, complete view (before preparation). Medullary rays very slightly sinuous.


Fig. 8b. Upper edge, detail (without preparation). Quarter cutting. Surface of the plank more irregular than on the other edge (Fig. 8a).



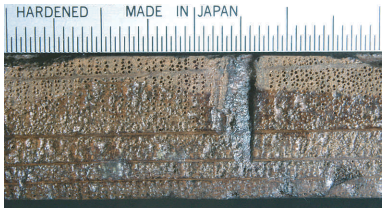



Fig. 8c. Lower edge, two details after preparation (cutter, partially, and brush). Full quarter cutting. Slow growth at the start (on left), slowing even more to become very slow at the end of the sequence (on right). Example of slight damage to the wood that interrupts the series of rings (on right).

Fig. 9. Panel of *God the Father*, right plank (P463/03) © P. Fraiture (IRPA/KIK)

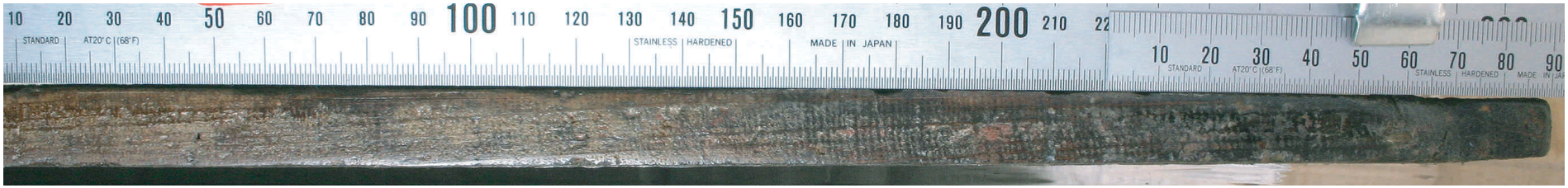



Fig. 9a. Lower edge, complete view (before preparation). Medullary rays slightly sinuous.

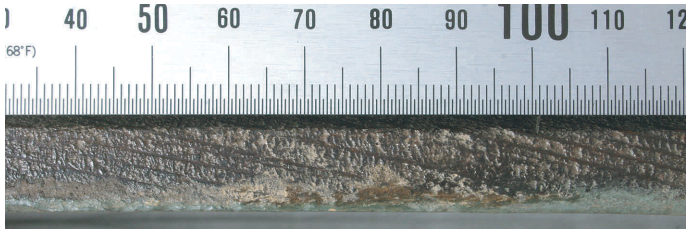
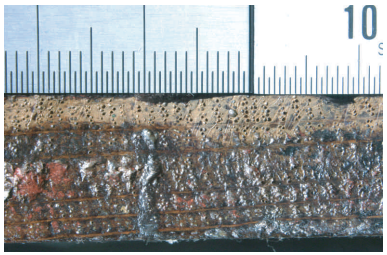



Fig. 9b. Upper edge, detail (without preparation). Quarter cutting. Surface of the plank irregular.



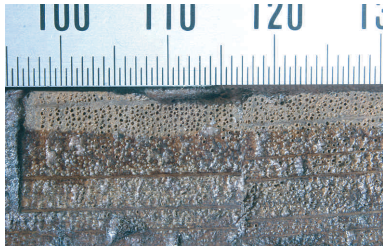


Fig. 9c. Lower edge, two details after preparation (cutter, partially, and brush). Full quarter cutting. Slow growth at the start (on left), progressively slowing to become very slow at the end of the sequence (on right). On the right, joint between planks P463/02 and P463/03, both from the same tree.

Fig. 10. Panel of *Saint John*, left plank (P464/01) © P. Fraiture (IRPA/KIK)


Fig. 10a. Lower edge, complete view (without preparation). Medullary rays fairly sinuous.

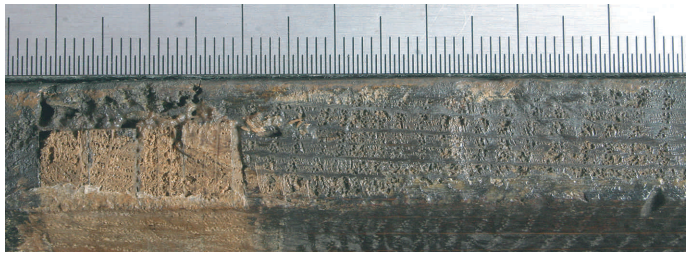
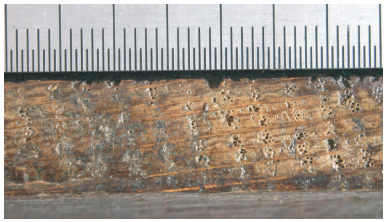


Fig. 10b. Upper edge, detail (without preparation). Full quarter cutting. On the left, sapwood almost entirely replaced by healthy wood. On the right, traces of non-original sawing.



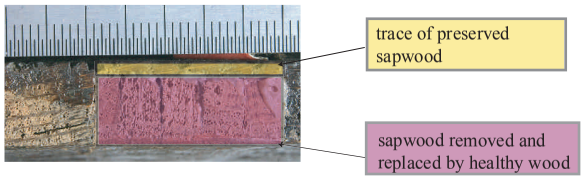



Fig. 10c. Lower edge, two details (without preparation). Full quarter cutting but medullary rays sinuous. Rapid growth. Sapwood almost entirely replaced by healthy wood (on right).

Fig. 11. Panel of *Saint John*, central plank (P464/02) © P. Fraiture (IRPA/KIK)

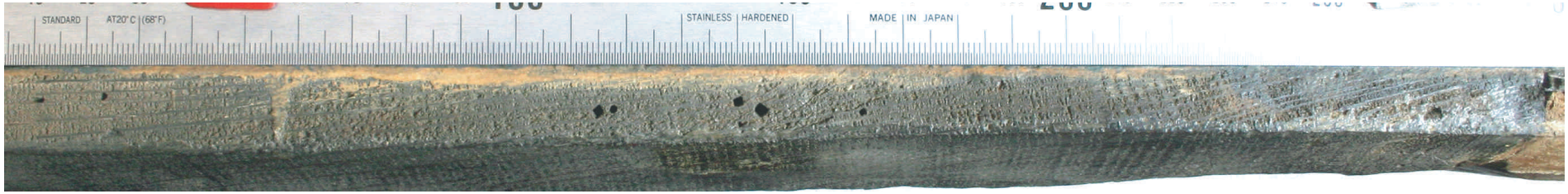



Fig. 11a. Upper edge, detail (before preparation). Medullary rays very slightly sinuous especially at the end of the sequence (left in the photo).

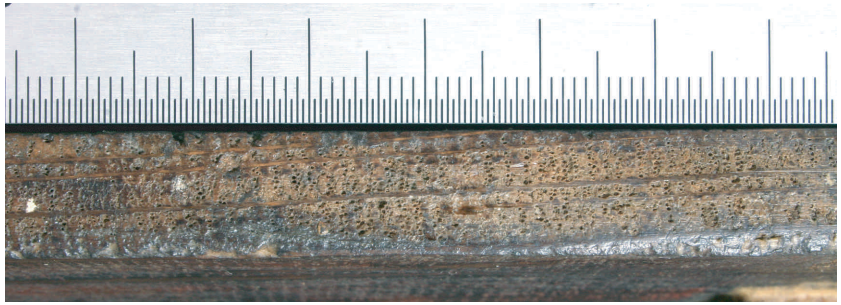
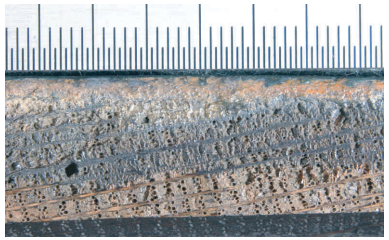


Fig. 11b. Lower edge, detail (without preparation). Full quarter cutting but rays slightly sinuous. Wood porous yet also very hard, difficult to prepare superficially for dendrochronological reading.



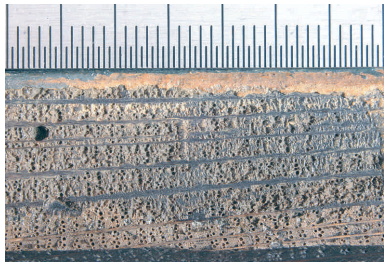


Fig. 11c. Upper edge, two details after preparation (cutter and brush). Quarter cutting. Medium to slow growth.

Fig. 12. Panel of *Saint John*, right plank (P464/03) © P. Fraiture (IRPA/KIK)

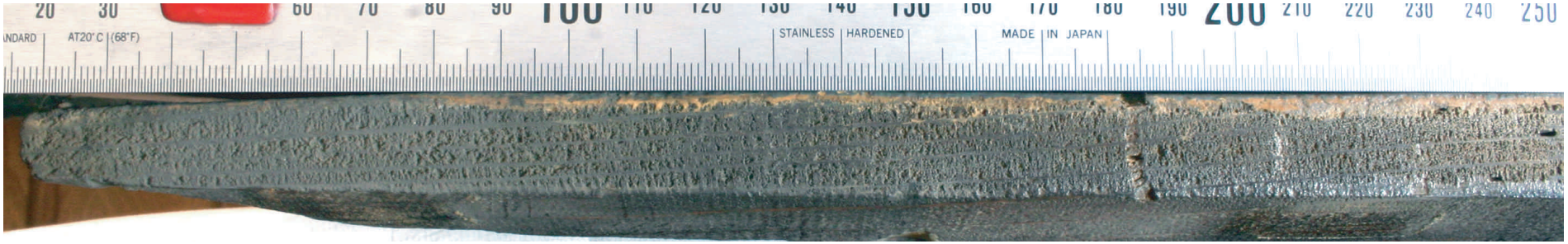



Fig. 12a. Upper edge (before preparation). Medullary rays sinuous, mainly at the end of growth (right side).

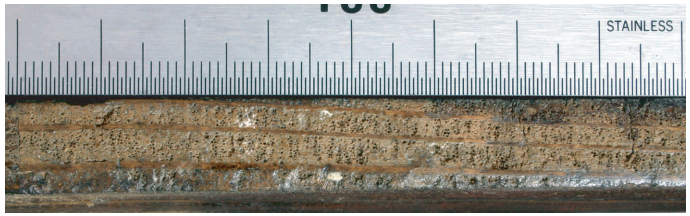
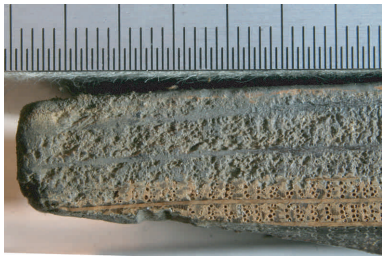



Fig. 12b. Lower edge, detail (without preparation). Full quarter cutting. Medullary rays slightly sinuous. Wood porous yet also very hard, difficult to prepare superficially for dendrochronological reading.



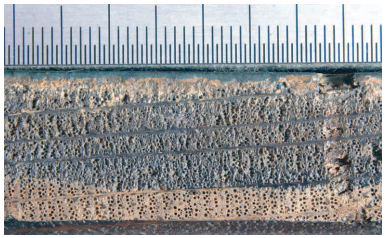


Fig. 12c. Upper edge, two details after preparation (cutter and brush). Full quarter cutting. Fairly slow and regular growth (on the right) with slowing at the end of the sequence (on the left).

Fig. 13. Panel of the *Virgin Mary*, left plank (P465/01) © P. Fraiture (IRPA/KIK)

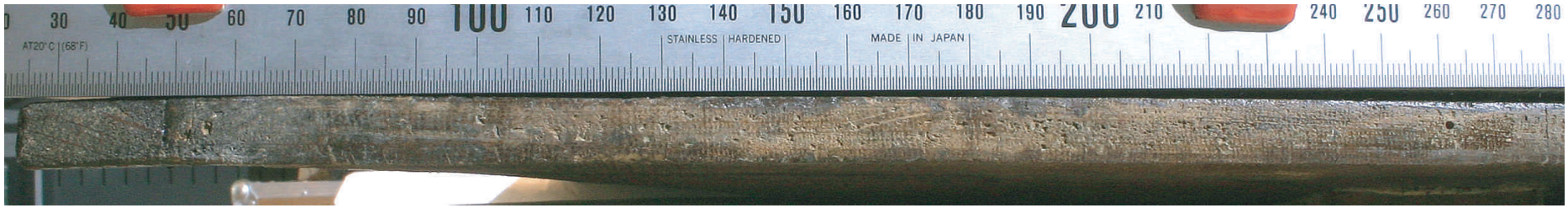



Fig. 13a. Lower edge (before preparation). Medullary rays very slightly sinuous.

Fig. 13b. Upper edge, detail (without preparation). Full quarter cutting. Surface of plank irregular.

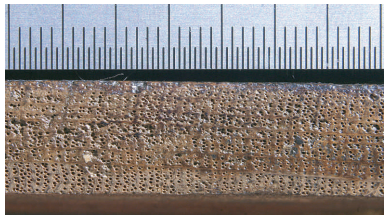


Fig. 13c. Lower edge, detail after preparation (cutter and brush). Full quarter cutting. Very slow growth.

Fig. 13d. Back, detail of the sapwood (light in colour) preserved on the left plank.

Fig. 14. Panel of the *Virgin Mary*, central plank (P465/02) © P. Fraiture (IRPA/KIK)

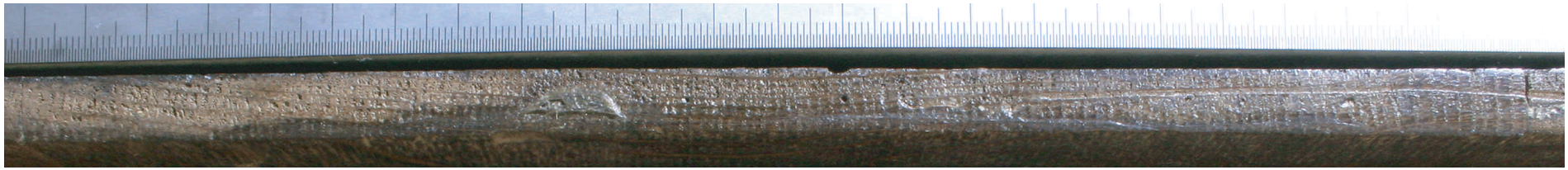


Fig. 14a. Lower edge (before preparation). Medullary rays slightly sinuous.

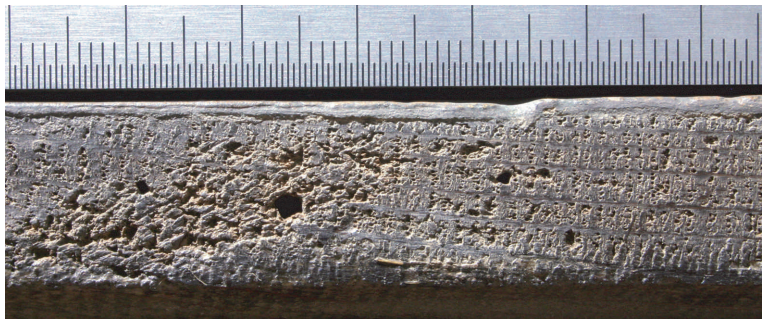
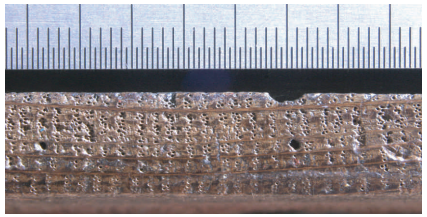


Fig. 14b. Upper edge, detail (without preparation). Full quarter cutting. Surface of plank irregular.



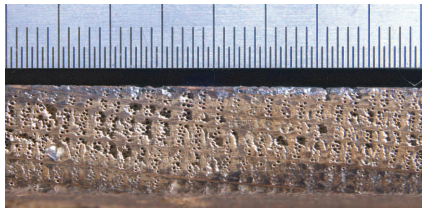


Fig. 14c. Lower edge, two details (after preparation by brushing). Full quarter cutting but medullary rays sinuous. Relatively rapid growth (in comparison with the majority of the other planks in the altarpiece).

Fig. 15. Panel of the *Virgin Mary*, right plank (P465/03) © P. Fraiture (IRPA/KIK)


Fig. 15a. Lower edge (before preparation). Medullary rays sinuous, in particular at the start of growth (on right in the photo).

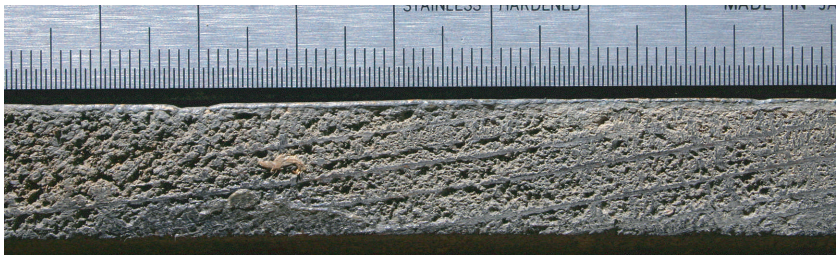
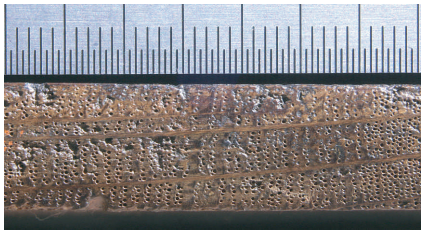


Fig. 15b. Upper edge, detail (without preparation). Quarter cutting. Surface of plank irregular.



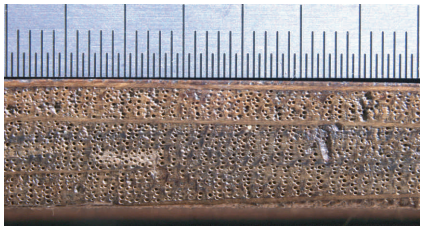


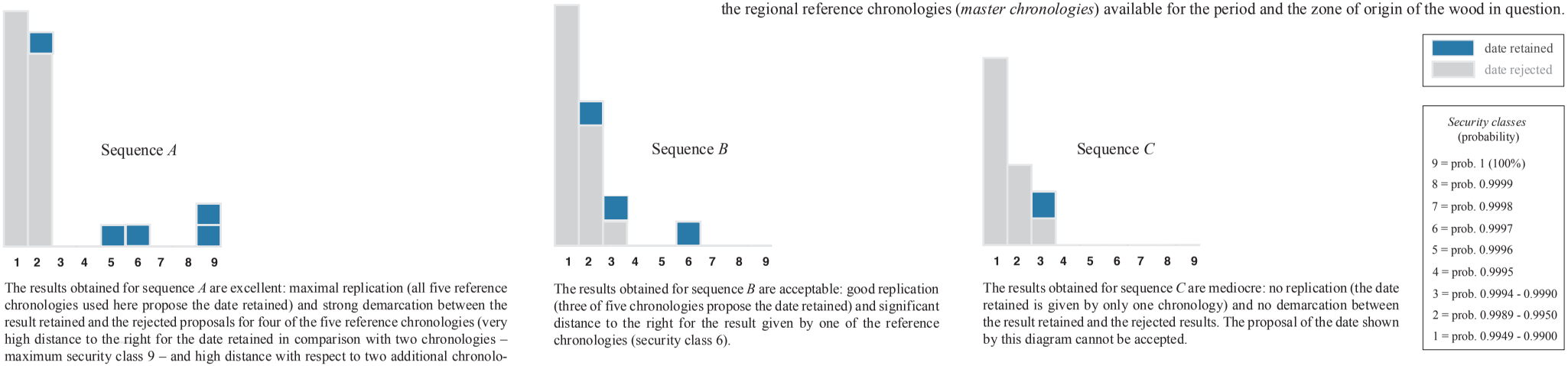
Fig. 15c. Lower edge, two details (after preparation by brushing). Full quarter cutting, medullary rays sinuous. Growth first irregular (on the left) and then slow (on the right).

# Interpretation of graphic illustrations of the results produced by the *Dendron II* system

When dating a wood sample, the *Dendron II* program calculates the similarity between the tree-ring series to be dated and those of the reference chronologies using different statistical tests, and this for all positions of the first sequence on all of the others. It then proposes the four or five best results obtained on each reference chronology, that is, in the best case, the correct result and three or four false results, and in the worst case, four or five false results. The originality of the two kinds of graphics presented below lies in the representation of the result accepted among the rejected proposals, as an argument supporting the relevance of the conclusions advanced.

The *P distributions* or *combined Girardclos diagrams* represent the best chronological positions proposed by *Dendron II* when calculating the sequence to be dated against the reference chronologies. The result obtained for the date retained on each chronology is shown in blue, rejected proposals in light grey. The more a proposal is replicated and deviates from the others (to the right of the graphic), the more it is reliable.

The *diagrams of P distributions* are useful for presenting the results obtained on several reference chronologies, up to ten; more than this and they lose clarity. This is why we use this graphics to show the quality of synchronisations between the series to be dated and the regional reference chronologies (*master chronologies*) available for the period and the zone of origin of the wood in question.




The results obtained for sequence *A* are excellent: maximal replication (all five reference chronologies used here propose the date retained) and strong demarcation between the result retained and the rejected proposals for four of the five reference chronologies (very high distance to the right for the date retained in comparison with two chronologies – maximum security class 9 – and high distance with respect to two additional chronologies – security classes 5 and 6).

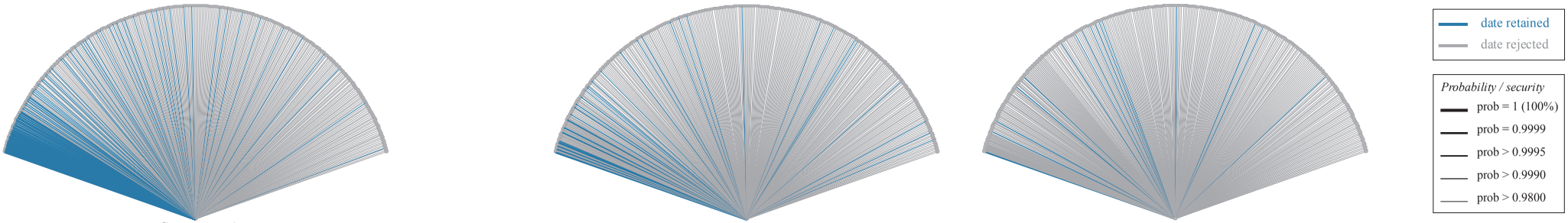
The results obtained for sequence *B* are acceptable: good replication (three of five chronologies propose the date retained) and significant distance to the right for the result given by one of the reference chronologies (security class 6).

The results obtained for sequence *C* are mediocre: no replication (the date retained is given by only one chronology) and no demarcation between the result retained and the rejected results. The proposal of the date shown by this diagram cannot be accepted.

The principle of *P distributions* is derived from Girardclos 1999. The concept of combining the diagrams is due to Lambert 2006; these are produced by the *Dendron II* program.

The *fan correlations* represent the best chronological positions proposed by *Dendron II* for calculation of each sequence to be dated in comparison to the reference chronologies. The result obtained for the date retained on each chronology is shown in blue and the rejected proposals in grey. The more a proposal is replicated (the higher the presence of blue lines) and the higher the probability obtained for the proposal (the thicker the lines and the more they are located in the left part of the graphic), the better the reliability of the date retained.

For this kind of representation, the higher the number of reference chronologies, the greater the significance of the graphics. This is why such graphics are used to show the quality of the synchronisations between the chronology to be dated and the numerous individual ring series from works of art of the period and the region from which the wood originated.




The results obtained for sequence *A* are excellent: replication is extremely high and good-quality results (high security) are very common (left side of the graphic).

The results obtained for sequence *B* are acceptable, both with respect to replication and the quality of the results obtained.

The results obtained for sequence *C* are mediocre: replication is low, considering the significant number of chronologies in the reference database, and this, moreover, does not provide results with high probability (few blue lines on the far left). The proposal of the date illustrated by this graphic cannot be accepted.

The principle of *fan correlations* is due to Lambert 2006; these are produced by the *Dendron II* program.