GLASMALEREI PETERS STUDIOS

Studios for restoration and preservation of historic monuments

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GLASMALEREI PETERS STUDIOS

Workshops for restoration and preservation of historical monuments since 1912

Studio Paderborn

Stained glass as artistic window decoration for sacred and secular buildings has existed for over a thousand years. Stained glass includes both „painting on glass“ and „painting with glass“; in the latter case, coloured glass is used instead of oil and watercolour paints. No natural paint, no matter how expensive, can surpass the incomparable transparency and luminosity of sun-drenched glass windows.

We are a family business, now run by the fourth generation, and have been for over 100 years. Our workshop has dedicated itself not only to the preservation, maintenance and refinement of old arts and crafts traditions in the sacred and profane areas, but also to the unusual, innovative techniques of today. And true to our maxim „Plus Ultra“, we always like to go one or more steps further and experiment for you. In doing so, we research not only out of enthusiasm, but also with success: joint projects with various renowned research institutes on topics such as silicate research or photovoltaics speak for themselves. Because the demands on glass design and its possibilities are constantly changing and developing, we are also continuously expanding and modernising the equipment in our workshops with ultra-modern furnishings and state-of-the-art technology. New productions are now sent to all parts of the world - England, Scotland, USA, Canada, Indonesia, China, Taiwan, Korea, etc. In addition to the realisation of extensive new glass art projects according to the designs of renowned artists, the restoration of existing historic windows takes up a great deal of space.

Altenberg Cathedral, and the cathedrals of Seville, Girona and Chartres, for example, are considered to be extraordinarily important restorations of our workshop.

Restoration studio, Paderborn

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The restoration workshop

The restoration workshop

For the creation of concrete, object-specific restoration concepts, we are in close collaboration and discussion with the responsible monument conservators, scientists and art historians. This enables us to offer specific solutions for individual questions and problems. Our workshop and our team have a wide range of techniques, procedures and equipment at their disposal, always ready to educate themselves further and develop new methods. In this way, we can guarantee that we can cover the diverse requirements profile of monument conservation work. Our numerous collaborations have always proved fruitful. For example, we would like to point out the first „lead-free stained glass“, which in turn was initiated by a heritage conservation project within the framework of a one-panel back-plating.

We are happy to provide advice as part of preliminary planning on site, show possibilities based on extensive archive material and prepare corresponding non-binding offers, including photographic documentation and expert opinion. Our range of services extends from minor repair and re-sealing work to extensive large-scale projects.

Ethical principles
The preservation and maintenance of historic stained glass is a matter of great concern to us. The top priority in restoration is the comprehensive conservation of the original material. Our restorers are committed to the ethical principles of the Venice Charter and the guidelines of the Corpus Vitrearum Medii Aevi. In order to be able to meet the requirements of the rapidly changing conditions in the field of monument conservation and restoration even more effectively, a specialised department for the restoration of historic stained glass has been established and a team of academic restorers and stained glass artists has been recruited for this purpose.

Networks
With the establishment of this new department, a network of partnerships and cooperations has developed that enables the company to offer customised solutions within the framework of advanced, state-of-the-art techniques and the latest findings. Equipment, including the most modern technology, also plays a major role.

Documentation, conservation and restoration
At the beginning of every restoration project there is a detailed preliminary examination of the inventory and an inspection of its condition. The restoration concept is then drawn up and discussed with the responsible monument conservators, owners and architects. Once the restoration has been approved by the monument conservators, the actual work can begin, such as consolidating the paint layer, cleaning the glass surfaces, edge-bonding cracks, reversible retouching, removing plating, soldering lead cracks, necessary additions, etc. Accompanying the conservation and restoration work is a comprehensive photographic and written documentation of the work, according to the requirements.

Further training and publications
The training and further development of our staff is an important and personal concern of ours. By attending and actively participating in specialist restoration conferences and research projects, our staff are continually trained and informed about the current state of research in glass restoration. The preparation of specialist lectures and publications on our work are an integral part of the daily routine in the restoration workshop.

Technical equipment
For documentation purposes, we have high-quality equipment including large-format cameras, reflex cameras, digital reflex cameras, microscopes, etc. and a professional photographic room with ideal, adjustable lighting conditions. Graphic documentation is possible both manually and digitally on mapping devices.

We have nebulizers for the treatment of microbial infestation, various climate measuring devices and we are very familiar with the handling of glass sensors in the interspace between stained glass and protective glazing.
F
or transport, we offer data loggers that monitor the vibrations to which the goods are exposed in transit.

Dalle de Verre restoration workshop

Assembly and final inspection in the exhibition tower

Photographic Studio

Assembly coordination

St. Maria, Altenberg (Altenberg Cathedral)

Restoration of the Gothic west window, ca. 1390 and installation of protective glazing

Planning
Decisive for the removal of the west window were the restoration works at Altenberg Cathedral. As a protective measure, it was planned to remove the prominent and valuable window to safe storage for the duration of the construction period. After the preliminary investigation, however, it was decided to carry out a comprehensive restoration, and a structural recalculation of the window tracery established that it would be possible to install protective glazing.

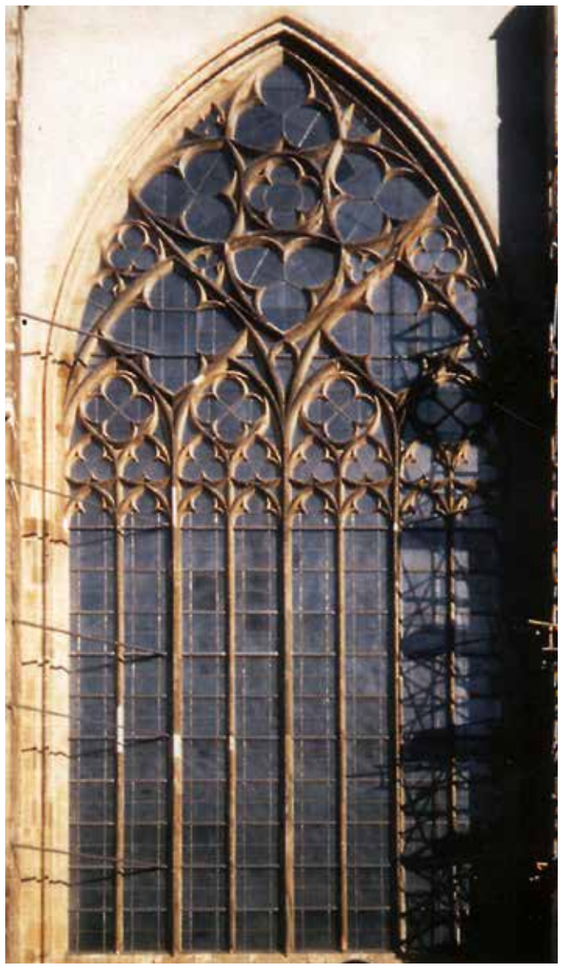
Investigation
Originally, only a gentle dry brush cleaning and the edge-bonding of cracks was planned for the west window. However, during the scientific investigations, it was discovered that a large number of harmful micro-organisms were present on the glass surfaces. These microorganisms exacerbated the damage already present on the painting layer and glass.

Documentation and damage mapping
Based on the existing photographic documentation from 1965, it could be comparatively determined that the corrosion on the glass surface had intensified and expanded over a wide area. To allow this development to be observed in detail in the following decades, it was decided to carry out extensive documentation. Medium-format slides were used to record the condition of the panels before, during and after restoration.

The differently occurring damage phenomena were documented with 35mm slides which, collated as a damage catalogue, formed the basis of the subsequent mapping. Initially, the mapping was planned on the basis of rubbings on a scale of 1:1, but the format was reduced to A3 size for better archiving. The inventory, the condition and the conservation interventions were then mapped.

Only after completion of the investigations and the mapping of the preliminary condition could a restoration concept be developed, in close coordination with the Brauweiler Monument Authority, the Cologne Cathedral Building Lodge and the BLB NRW and, after approval, the restoration itself could begin.

West window, c. 1390



Installation of protective glazing with slightly frosted panels

Protective measures
In order to adequately protect the historic stained glass from damaging weather influences, internally ventilated exterior protective glazing was installed, whereby the original window is moved into the interior and the protective glazing takes over the function of the weather shield.
Consequently, condensation only forms on the inside of the protective glazing and no longer on the original glass. Internal ventilation is important for functional exterior protective glazing.

Attaching the glass sensors to the outside of the protective glazing

Monitoring the protective glazing
In order to monitor the effectiveness of the protective glazing in the long term, glass sensors were installed on the outside and inside and in the interspace in cooperation with the Fraunhofer Institute for Silicate Research. The influence of moisture, temperature changes, pollutants and microorganisms at the point of use is quantified at the glass sensors in the laboratory by IR spectroscopy and recorded with a simple numerical value (E-value).
The protective glazing must meet not only functional but also aesthetic requirements. In the case of Altenberg Cathedral, the protective glass was therefore coated with a matt layer of paint on the outside in order to artificially imitate the missing patina. In addition, it was decided to incorporate the lines of the original panels as a lead net into the protective glazing. In this way, it was possible to approximate the original exterior appearance of the cathedral and its windows. This protective glazing at Altenberg Cathedral is an example of visually successful glazing which, with its geometrically simple forms, blends unobtrusively into the exterior appearance.

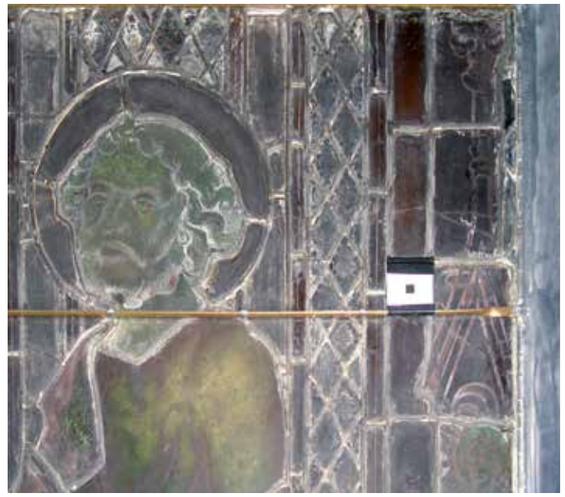


Fig. 1 - Glass sensor on the inside

Fig. 2 - Glass sensor on the outside

Moses window, after a design by Albrecht Dürer, c. 1498

Investigation, documentation and damage catalogue
In 2005, the medieval stained glass of the Moses window (SVII) was removed and visually examined. Subsequently, the inventory and the condition of the individual panels were documented. The various types of damage and surface coverings were recorded photographically in a detailed catalogue. The damage phenomena that occurred were typical of church glazing that had been without conservation care for a long period of time.

Numerous cracks had appeared on the Moses window. The interior surfaces were covered with a layer of soot and dust on the one hand and contaminated by a brownish deposit on the other. This was a microbial infestation of the surfaces, present to an alarming extent. On the outside, the window was heavily soiled with pigeon droppings. The existing lead (replaced around 1900) was in satisfactory condition. Although numerous lead cames were broken and deformed, the extent of the damage was not serious enough to warrant replacement of the lead matrix.

Extremely serious damage was found on the paint layers. The black grisaille paint applied in several layers had loosened in places and was detaching from the glass surface. The main causes of the progression of damage were thought to be the condensation on the inside of the original panels and the increasing changes in humidity and temperature. Other reasons for this damage to the paint layers could also be the use of unsuitable restoration materials or subsequently applied coatings. To verify the causes of the damage and as a basis for drawing up an individual conservation concept, samples were taken and sent for analysis.

Topographical 3D documentation.
For this reason, it was decided to carry out a comprehensive and supplementary documentation of the glass surfaces. The most important criterion for the choice of documentation method

Restorer Markus Kleine and art historian Hartmut Scholz during the preliminary examination

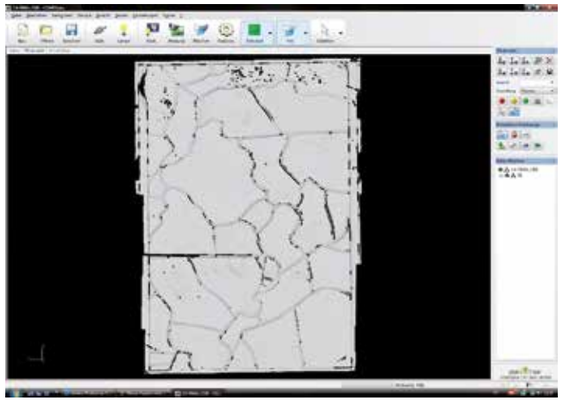
was the usability of the documents for future damage monitoring. The method considered was non-invasive 3D white-light strip projection, with which the topography of surfaces can be recorded without distortion and geometric data for grisaille paint-based glass paintings are highly informative despite their colour neutrality. By comparing the status quo with older photographs, chronological analyses can be made from which material losses or the occurrence of deformation and stress cracks can be deduced. Another benefit of the method for some types of glass is the detection of surface defects and the visualisation of fire residues or optically conspicuous corrosion layers.

This opens up two perspectives: On the one hand, the 3D data sets are suitable for objective monitoring of deterioration. On the other hand, the superimposition of the 3D data with older photographs allows the reconstruction of lost layers of paint in favourable cases. This can be important in the case of scientific questions and reconstructive restorations.
Even beforehand, the photographic comparison of the status quo of the window with older photo cycles showed a clear loss of contour lines.

Evaluation of the surface information
During the measurement campaign carried out in 2005, all twenty-four painted faces of the main medieval scene of the Moses window were digitally recorded. One of the panels (SVII 4c) was also recorded on the reverse side. For visual comparison of the data sets, they were then superimposed on different levels using image processing programmes. By superimposing the photographic status quo and the scan data, it was possible to make parts of the lost contour drawings and the internal hatchings of painted objects legible again.
On the one hand, the results are relevant for the reconstruction of artistic concepts and the attribution of drawing styles to stained glass workshops. On the other hand, conservators have the possibility to reconstruct the contours or hatchings virtually and in reality.

Virtual reconstruction of lost painting
A virtual retouching was made on the detailed section of Moses' head on the basis of the photograph from 1943 and the actual 3-D-Scan.

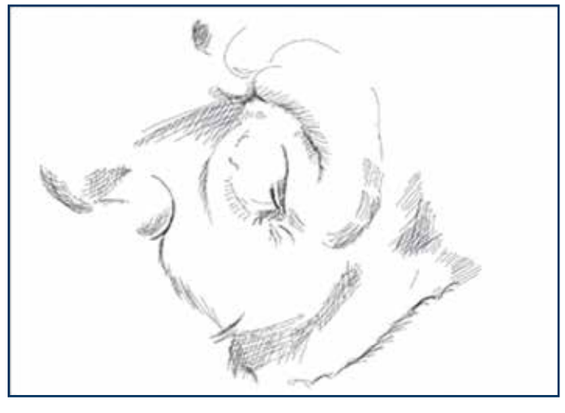
3D-Scanner - Zusammenarbeit mit der Universität Bamberg



3D scan on the monitor

Moses' head without retouching - condition today

Moses head with heavy retouching, approx. 100% possible condition in the period of origin. All hatching lines are not clarified.



Retouching approx. 100%

Notre-Dame-de-Chartres Cathedral in Chartres is the „archetype“ of the High Gothic cathedral. In 876, Charles the Bald consecrated a church there. The present Gothic rebuilding began shortly after 1194 and lasted until 1260. In 1979 it was included in the UNESCO World Heritage Register.

Chartres is unique in several respects. The church appears absolutely dominant in what is still a relatively small city, and thus even today it roughly conveys the impression it has made on contemporaries since the 13th century, when such a structure stood like a supernatural-divine symbol in the secular environment. Chartres has never been destroyed. While in many cathedrals the portal figures perished in the iconoclasm of the Huguenots or the French Revolution and countless stained glass windows fell victim to the taste for more light, in Chartres the highly significant sculptural decoration of the cathedral has been preserved almost intact, as have almost all of the 176 windows. Therefore, no other cathedral can convey the atmosphere of the High Gothic period so dramatically.

Window 116 dates from 1228 to 1231. It is a two-light clerestory window with two larger-than-life figures facing each other. The upper region of the window is formed by a large, multi-part rosette consisting of a circle with eight leaves surrounded by twelve quatrefoils. In lancet A, a clergyman with tonsure, left, and St Nicasius, right, are depicted. Both figures are identified by the attributes of a halo and a book. The clergyman bears the inscription S.X[IST]OFOR[US] above his head, which suggests that this is St. Christopher, but the lectionary in Chartres describes the figure only as a very tall, bearded layman, which makes the attribution uncertain. The bearded figure on the right bears the inscription S.NICHASIVS at the base. Both representations are characterised by their larger-than-life, elongated design, as well as the unnatural and stiff posture. At the base of the window, the figure of the founder, a clergyman, extends over two rows, his hands raised in prayer. Next to him is a cross with the birth cloth of Jesus. The lancet B shows as a standing figure, on the left, Saint Dionysius handing over the Oriflamme to Jean Clément. The inscription S. DIONISIVS, as well as a mitre, halo and a book in his left hand identify him. The right figure is characterised by the knightly armour with the coat of arms of the Clément family as a chest ornament. This coat of arms is also repeated at the base of the lancet. The lancet B differs from the lancet A mainly by the slightly curved posture of the figures, a floral border design and greater coherence of the representation. The rosette, centrally above the two lancets, shows John the Baptist as a bearded man in a fur robe with a red halo, the Lamb of God on his left arm. The figure is surrounded by floral decoration and the coat of arms of the Clément family at the bottom. The images in this part of the window are again different from the two lancets and seem to form a link. Above all, the floral design elements, such as vines, four-leaved plants and cross-hatching, are taken up by both lancets, but parallels can also be found in the figural representation, e.g. in the drapery, the first signs of an individualisation of the figures. In total, the window ensemble comprises 117 individual panels of various sizes.

Window 116, lancet A before restoration

Window 116, lancet A after restoration

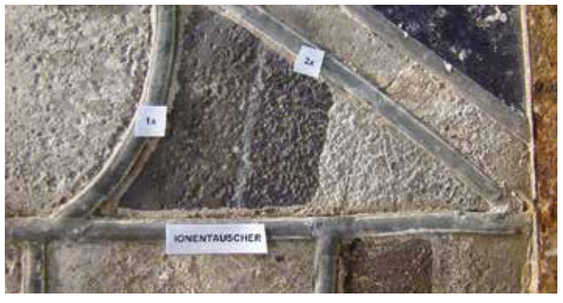
Window 116, lancet B before restoration

Window 116, lancet B after restoration

Cleaning under the microscope

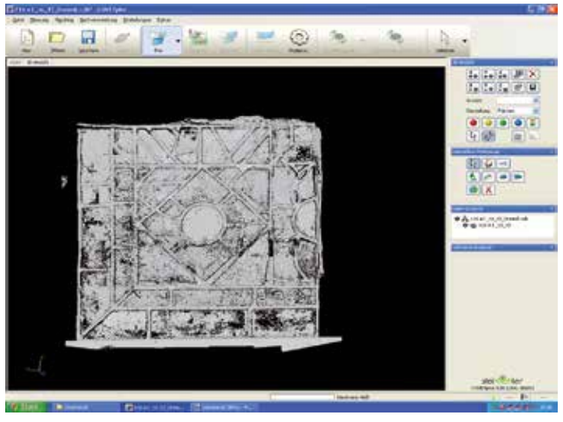
Creation of a 3D white light scan

Removal of the mending leads and edge-bonding of the cracks



Reinigung mit Ionentauscher

After their removal and transport to Paderborn, the individual panels were professionally photographed in our in-house photographic studio for detailed documentation. The photographs then served as the basis for the digital mapping of the damage found on the lead, glass and paint. The mapping is done directly on the computer in the workshop using special programmes in order to achieve the highest possible accuracy and to reproduce the documentation as often as desired without any loss of quality.



Ergebnis eines 3D Weißlichtscans

As an example, a 3D white light scan was also carried out on one panel. In cooperation with the University of Bamberg, this device was tested for topographical surface analysis in order to obtain detailed information about the removal of dirt and corrosion layers and, if necessary, to make lost painting visible again.

To clean the panels, the various layers and compositions of the corrosion products were analysed in cooperation with the LRMH (Laboratoire de Recherche des Monuments Historiques, France). On this basis, a restoration concept was drawn up, which was then presented to the owner and the architect.

The interior cleaning began with partial surface fogging using a 70% ethanol-water mixture. This process was repeated twice in order to kill active microorganisms and spores that reemerged after the fogging. Afterwards, a controlled brush cleaning took place under the microscope. At the same time, the fragile paint layers had to be secured with an acrylate. Loose layers of paint were laid down again by lightly heating them with a heating spatula. In order to treat the heavily corroded exterior, which was encrusted with corrosion products, the Peters glass painting workshop used a method that deviated from the traditional, slightly aggressive methods. Due to the composition of the corrosion product,it was possible to convert the corrosion crusts into an easily soluble product that could be lifted off with simple plastic spatulas

The advantage of the ion exchanger is that no aggressive solvents are applied to the historic material and the process is completed immediately after the batch is removed. The ion exchangers used are a resin that is applied in solid form and activated by distilled water. The process can be precisely monitored and controlled by the solid application form. Other agents such as EDTA, on the other hand, can be reactivated by condensation in the form of dried residue on the glass, causing further damage to the glass. The cleaning method we used, on the other hand, is absolutely risk-free and thus optimal from the point of view of monument preservation.

The result was ultimately more successful than attempts with other means and methods. In addition, we were able to leave a final protective layer of corrosion on the glass so as not to damage the gel layer underneath.

The reinstallation from 19 to 25 January 2013 was carried out dry, as the windows will in future be kept in their old place behind protective glazing surrounded by internal air - quasi museum-like.

Seville Cathedral, Spain

The use of CO32- ion exchangers to clean the “Enrique Aleman” windows.

Location of the „Enrique Aleman Windows“ c. 1460

Among its 109 windows, the Gothic cathedral of Seville has several stained glass windows by the German glass painter “Enrique Aleman” who was active in Spain. These windows are thought to date from around 1460. In this most recent restoration, the team at Glasmalerei Peters has the honour of restoring and conserving these windows. With every restoration, one comes across peculiarities and unusual features, and this was no exception. There was a hard coating on these windows that could not be removed by conventional cleaning methods. It was imperative to have this coating and its connection to the substrate examined more closely in order to find an adequate, damage-free cleaning method.

Initially, consideration was given to leaving the coating on the window so as not to expose the existing material to any unnecessary danger but, for three main reasons, action was imperative:

1. It was not possible to clearly define the hygroscopic properties of the coating; too much water storage would be corrosive for the historic glass.

2. Some of the layers proved to be extremely brittle and detached due to the tension with the substrate.

3. For these reasons, in consultation with the cathedral, both a representative piece of glass and smaller shard samples were taken and sent to the laboratory for scientific analysis.

The analysis sought to determine the following:

1. Overall composition of the glass and the painting
2. Binder analysis of the overlays
3. Possibilities of removing the layers while preserving the original substance

Thus, the structure of the glass painting as well as the overlay was precisely determined. The result was an astonishing layered structure of painting with a „protective overglaze“ dating from the time of manufacture, as well as a multi-layered structure of cold painting that could be determined in time to come.

Due to the high proportion of gypsum in the coatings, the transformation by ammonium carbonate compresses or an ion exchanger treatment was promising and gentle for the historic glass painting substance.

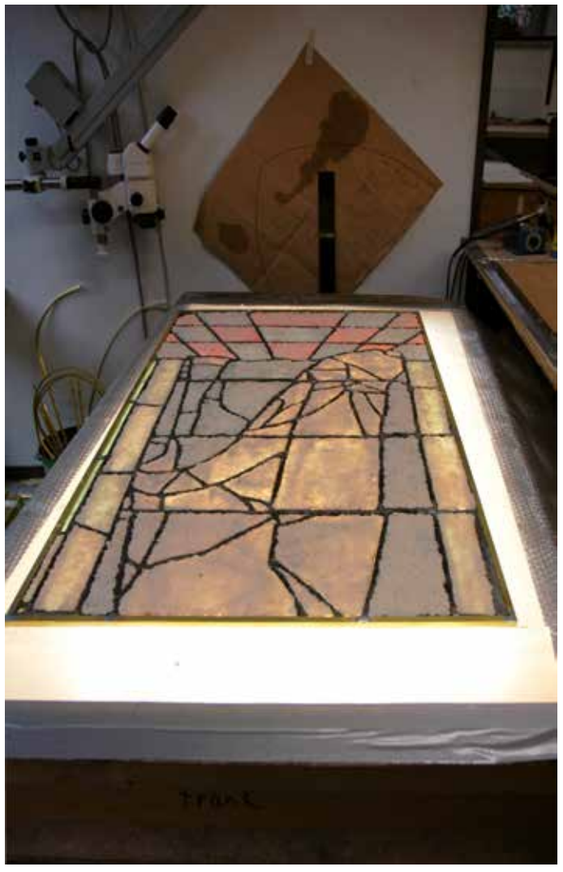
Thus, an anion exchanger loaded with CO32- was used to remove the calcium oxalate and gypsum crust on the Seville panels. When choosing an ion exchanger, it is important to consider the compounds formed by the specific loading. Sometimes detrimental compounds can be formed here.
The oxalate compound is so stable that no reaction can be expected here, but the gypsum can be „decomposed“ well by the ion exchange due to the SO4.

Ion exchangers are organic solids with a high surface area in the form of beads or crushed as powder. They are a water-insoluble, three-dimensional, high-molecular framework. Firmly attached to this so-called synthetic resin matrix are anchor groups with loosely bound counterions, which are readily exchanged for the ions of a liquid phase.

The principle of action of ion exchangers is based on the selective exchange of ions. Different ion exchangers (cations or anions) can be used in different ways. After the reaction is completed, the synthetic resin with the bound ions can be removed.

The cleaning result was very successful. The tension-rich layer was removed without damage and the theological message of the windows was clearly legible again.

This project shows how important it is to work in an interdisciplinary manner during restoration work, to include scientific investigation in the process and to develop a cleaning concept tailored to the surface coating.



Covering the glass surfaces

Removal of the compresses

Panel in transmitted light - before cleaning

Window in transmitted light - after cleaning

Cathedral of St. Mary in Girona, Spain

Reconstruction of lost painting with back-plating

The Cathedral of Santa Maria in Girona

Girona has an extraordinary wealth of imposing monuments in unparalleled density. The most famous church in the city is the Cathedral of Santa Maria, which has been worked on for centuries. Its façade and also the two rose windows are from the Baroque period, the flight of steps from the late 17th century. Construction of the church began around 1300 and the vault was not completed until the 17th century. The choir is modelled on Barcelona Cathedral. In 1417 there was a change of plan, and the nave was designed as a hall building. With a ribbed vault over a width of 23 metres and a height of 34 metres, it is the widest hall in the entire European Middle Ages.

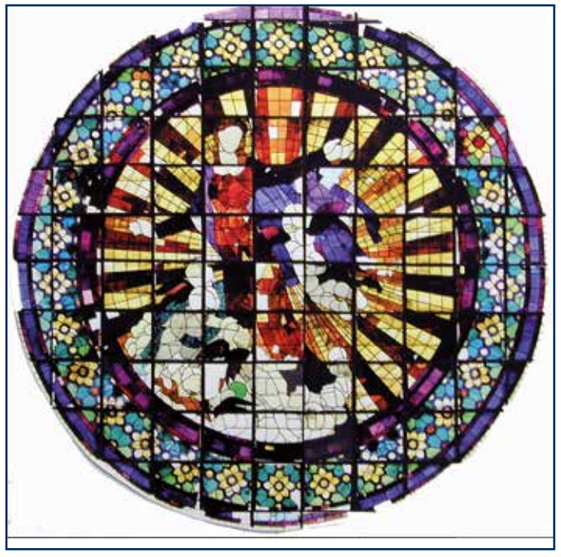
The restoration of the rosettes

The rosette windows were for the most part original, apart from a few panes of repair glass and a panel in the east rosette that was inserted later. On both rose windows, there were a large number of cracked panes and, in some cases, missing pieces of glass. There was conspicuous surface damage in the form of a grey haze that appeared exclusively on the violet glass. Most of the painting was very badly damaged due to the loss of adhesion. In large areas, the paint layer had peeled off over a significant area and the original design could only be seen at close range and under raking light. The missing paint had an aesthetically disturbing effect, especially in the figurative areas. The missing areas were so prominent that the legibility of the window was severely compromised. Therefore, it was decided to recreate the lost painting. Various proposals were developed and presented for this purpose. In consultation with the responsible monument conservators, the scope and type of execution were determined in detail. The additions were to be designed in such a way that they were reversible and also easy to remove.

Since the paint loss was very extensive, partial back-plating was discarded and all supplementary contours and overlays were applied in grisaille paint to a separate clear glass pane which was then fired. During assembly, these panes were then mounted in a package with the corresponding original glazing, which was thus restored to legibility in transmitted light, but without altering the original substance.

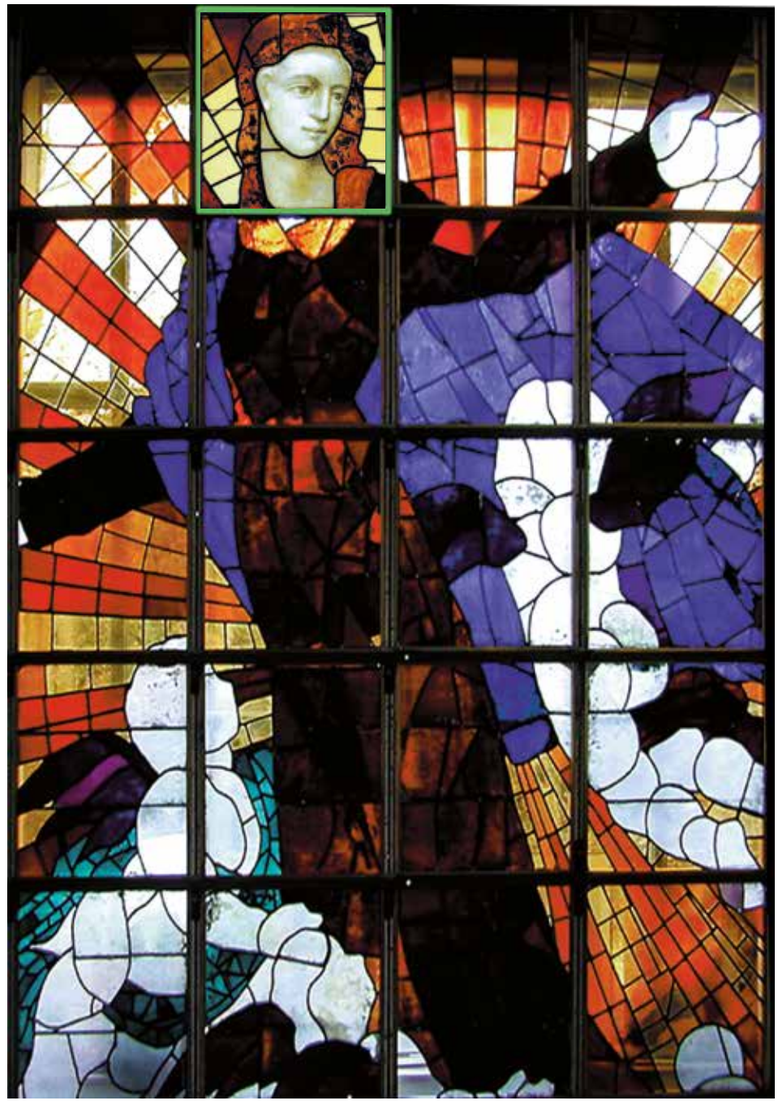
The supplementary clear glass pane can be removed at any time with little effort. Both rose windows have also received internally ventilated protective glazing.

West portal with rosette, diameter approx. 8 m



West rosette before restoration

West rosette after restoration



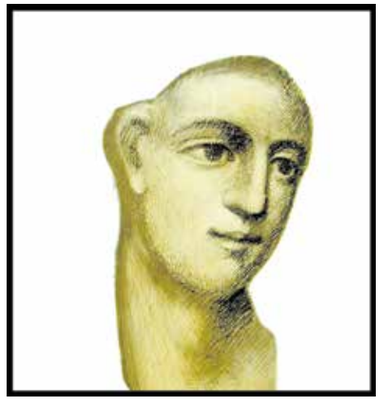
Original and doubling pane

Back plating

Two more of many design proposals for the reconstruction of the Mariakopf. We made these panes to show what would be possible.

In the end, together with the responsible monument conservation authority, we decided on a very restrained version.

Original pane



Doubling pane

Original and doubling pane

St. Gertrudis Catholic Church in Kuringen, Belgium

Restoration and reconstruction of the 19th century windows

At the end of the 19th and beginning of the 20th century, the Catholic Church of St. Gertrudis received new stained glass windows. The floral quarry design of the windows is typical of the region and the period. During the Second World War, a large part of the stained glass windows were destroyed, and the broken fragments and damaged frames were subsequently removed. Some larger lead matrix fragments were recovered and stored in the sacristy. In the course of time, the damaged stock fell into oblivion. The missing windows were replaced by simple rectangular quarry glazing made of mouth-blown antique glass.

At the beginning of the 21st century, the remaining fragments were rediscovered. The sifting and subsequent inventory showed that the 96 fragments found made up about fifty percent of the nave windows and seventy percent of the transept windows.

The decision was made to restore and partially reconstruct the nineteenth-century windows with the help of the remaining pieces found. A concept was developed in close cooperation with a local architect and the responsible monument preservation authority and executed in our workshop.

Four of the original ten windows could be reconstructed on the basis of the glass fragments found and sorted. Initially, it was planned to detach all the glass pieces from the existing lead nets and to lead them anew.

However, it proved possible to reform the original lead nets, supplementing them with a few new lead cames to form complete windows, thereby preserving much of the original material.

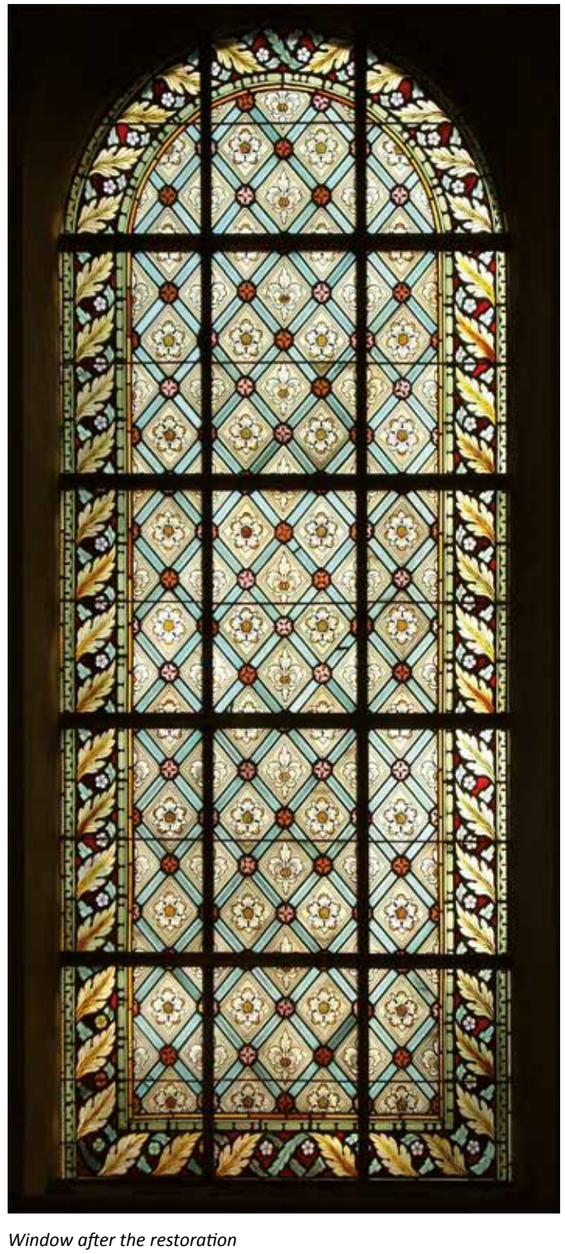
Thanks to the creative cooperation between the architect in charge, the monument preservation office, the municipality, the King Baudouin Foundation and the Peters workshop, bespoke solutions were also achieved for the remaining six windows.

Four of the six remaining windows were filled with modern glazing by a contemporary artist, and the other two windows with simple rhombic glazing blend in very well with the overall scheme. All the windows were installed with external protective glazing.

Original fragments stored in the church

Inventory

Assembling the fragments in the workshop



Window after the restoration

Post-war window

Before the restoration

After the restoration

Church of the Assumption of the Blessed Virgin Mary in Landeck, Austria

Restoration and completion of the Fidelius Schabet northern choir window of 1860 in the original style.

Fragments stored in the sacristy after rediscovery

In 2014, parish priest Mag. Komarek was able to recover window fragments during a clear-out of the sacristy attic. An initial inspection of the inventory revealed that they were 19th century glazing elements.

During the documentation of the window inventory the name of the designer and maker Fidelis Schabet, with the date 1860, was discovered inscribed on one of the glass pieces.

The artist, who came from Wurzach in Württemberg, lived and worked in the Munich area from 1834 onwards and created numerous paintings and murals, many of which survive to this day.

In this way, it was also possible to clearly establish the connection with the southern window still remaining in the choir, which is signed „Josef Dopfer's Glasmalerei in München" and bears the date 1862. By consulting historical photographs of the church

Signature of the artist „Schabet 1860" in the window

interior, it was possible to determine the exact position of the window on the north side of the choir.

The archive documents collected and the parallel search for the still-missing window fragments made a reconstruction drawing of the missing elements possible as a first step. The axial symmetry of the window facilitated the reconstruction and provided certainty for the design of the missing parts.

The study of the restored window fragments, which showed the high quality of the paintings by the artist Schabet, in connection with the reconstruction drawing made on a 1:1 scale, formed the basis for decisions by the monument conservation department and the episcopal art and building commission, which led to the overall reconstruction of the window. The aim was to make the additions as close as possible to the original, in order to re-establish a coherent overall impression.

First sighting of the fragments

Stained glass artist Eckhard Sehrbrock drew and painted the additions with great sensitivity

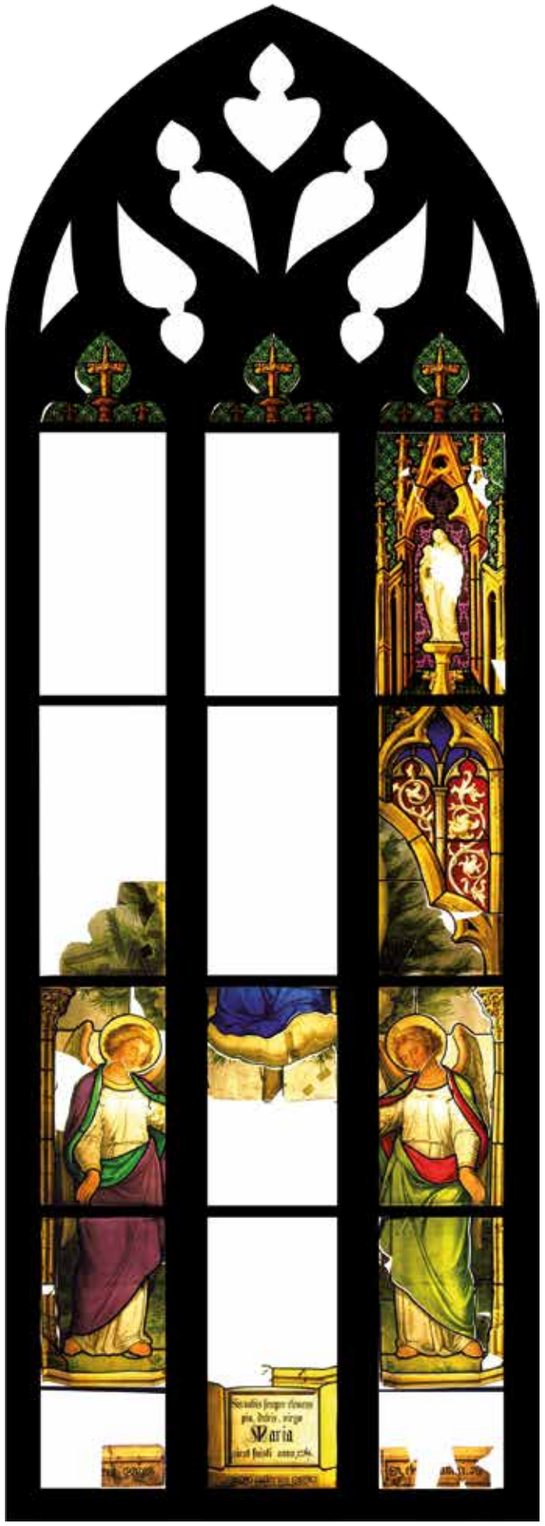
Discussion of the reconstruction drawing in the church

The window, created in 1860, is a testament to the neo-Gothic movement in the style of the „Nazarenes", whose design features such as graphic linearity, clear, two-dimensional compositions and strong colours are particularly well exemplified in this window.

View of the church interior 2018

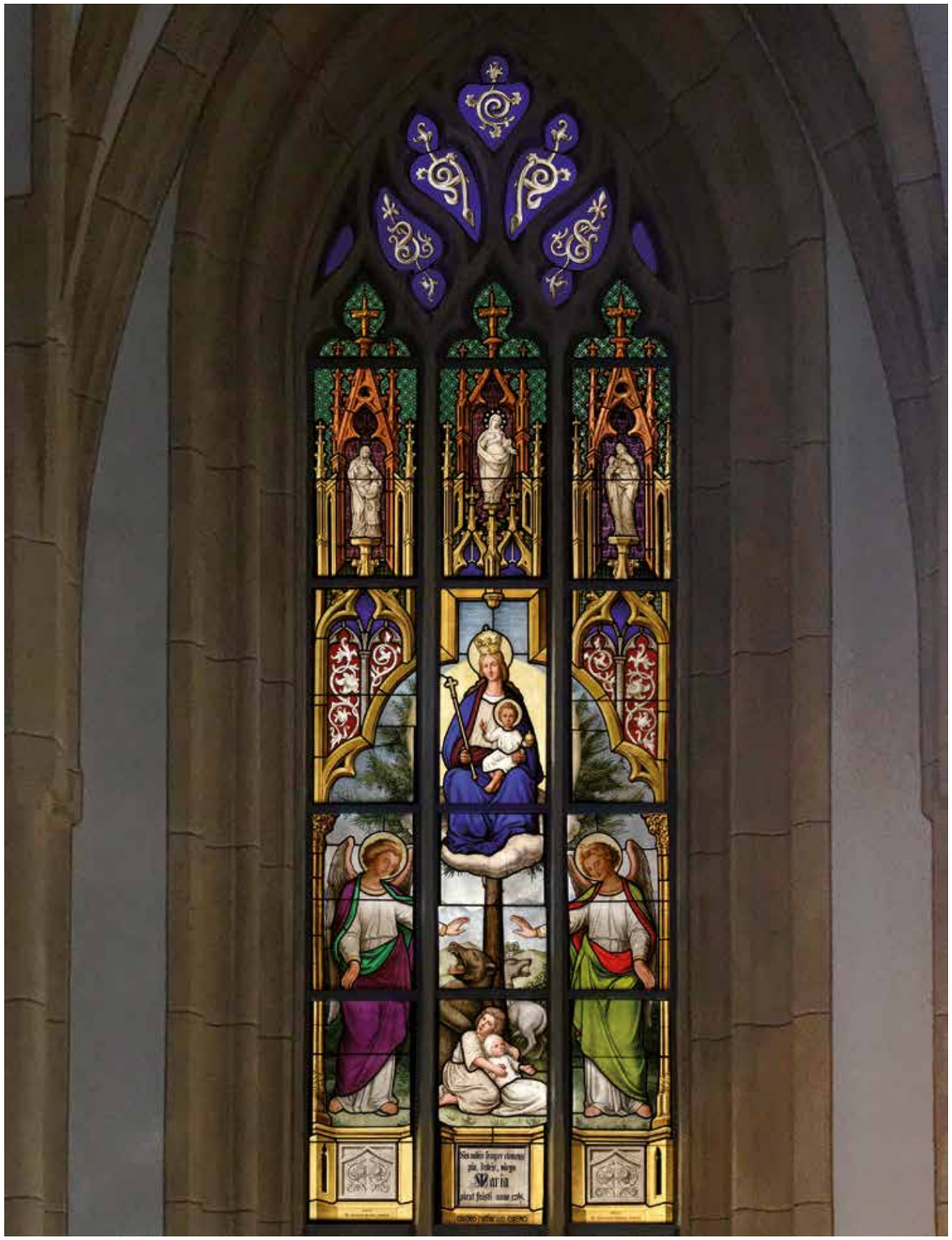
The choice of the motif with the depiction of the founding legend (finding of the lost children) shows the wish of the congregation to give the local legend a central place in the choir.

Dipl. (FH) restorer Ronja Lammers explains the restoration work



Original fragments 1860

Reconstruction drawing 2018



After the reinstallation of the reconstructed and restored choir window

Augustinian Museum Freiburg

Reconstruction of lost bull‘s-eye panes of the imperial windows from Freiburg Cathedral

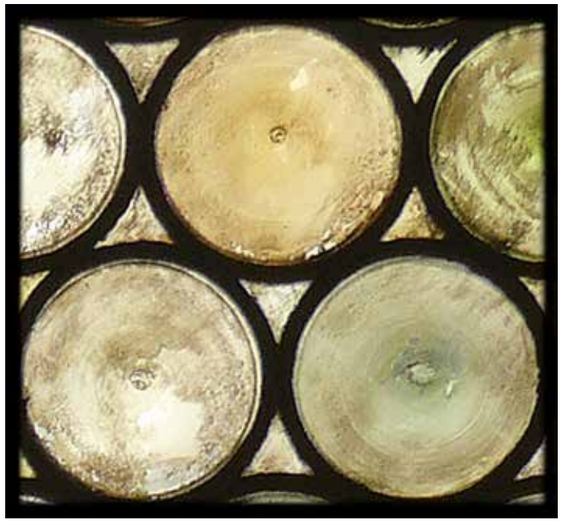
The museum, which was completely rebuilt by Christoph Mäckler, not only offers a special kind of art experience, but the architecture and interior design also constantly surprise visitors with new perspectives and views. The original stone sculptures and stained-glass windows of Freiburg Cathedral, paintings by Matthias Grünewald, Lucas Cranach the Elder and Hans Baldung Grien, as well as the impressive „Christ on the Donkey“ and the Passion Altar of the Housebook Master are among the highlights of the exhibition. The city‘s largest museum was established in 1923 in the former monastery of the Augustinian Hermits and is today one of the most important cultural history museums in Germany.

The historic stained glass windows of Freiburg Cathedral were long housed in a cellar. With this redesign of the museum, these windows will be given a new purpose and displayed to their full advantage. They will form part of the main entrance to the museum and illuminate the enormous central hall in the afternoon with the sun from the west, bathing it in a special light.
Another highlight of the stained glass collection will be found in the staircase of the building, where the Dominican window will be presented. The stained glass will thus be much more prominent than was previously the case. Not all parts of the imperial windows and the Dominican window have been completely preserved. The simplest solution would have been to leave the lost parts missing and present the remaining glass in the best possible way. But a museum not only has the role of making historical, nationally valuable objects accessible to the public in their state of preservation, but also to give the works a certain didactic quality and to present them in such a way that their context and perhaps also the liturgical background to their creation can be understood and experienced. In the example of the imperial windows, as in many works of the 16th century, in addition to the central richly painted main scene, the rest of the window was equipped with light, transparent Butzen (similar to bull’s eye) glazing. In many cases, this Butzen glazing is no longer completely preserved, as these panels were often not valued in the past. They were too often thought to be alterations from the Baroque period and consequently disposed of as worthless „trimming“ of the windows. On the imperial windows, too, only the painted panels have been preserved, which contain remnants of the Butzen glazing on the outer borders. In order to restore the overall effect of the windows and to free them from their trimmed state, additions had to be made that blend harmoniously with the window without any pretence of being a historical part of it.

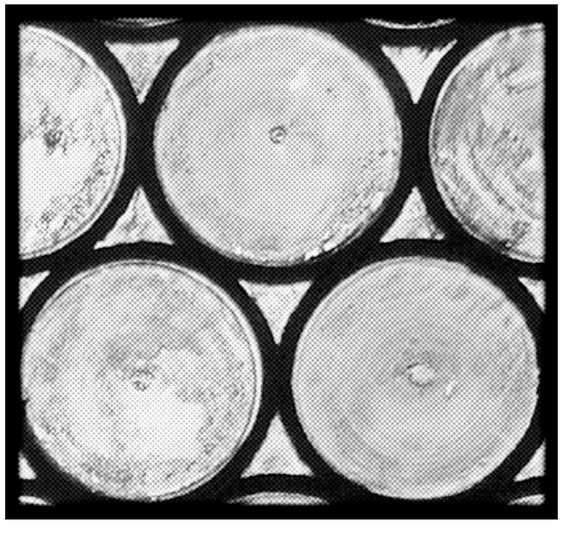
In order to fulfil these requirements and to find a didactically correct connection, we took high-resolution photographs of the preserved rows of Butzen and assembled them into a new panel. This overall panel was then processed into a dot grid and transferred to the panels by means of screen printing. By including the signs of ageing on the Butzen, the panels took on a special, independent life and were able to coexist with the original. However, during the first trial fitting it was noticed that the lack of colour of the new panels made them stand out, so a colour adjustment to the original was made using an airbrush.

The result is a harmonious overall picture without separation, yet old and new are clearly separated from each other, because the addition bears the craftsmanship of our time and does not aim to copy or forge.

Imperial window with the planned additions

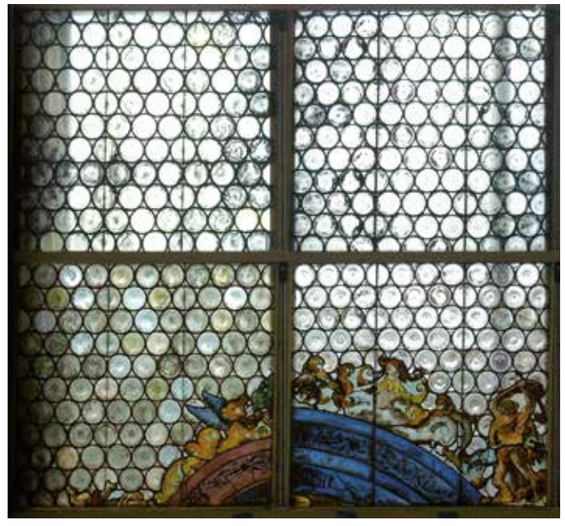


Original panel - detail



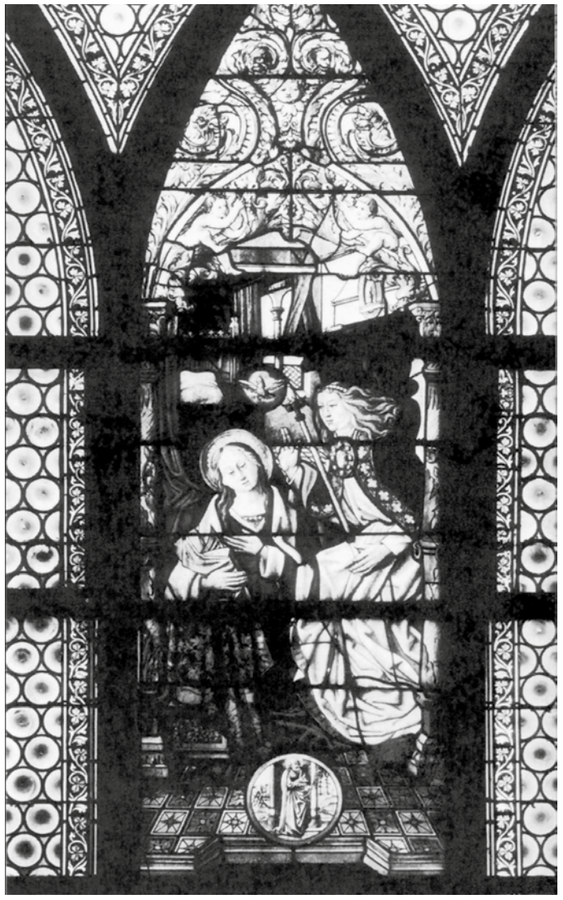
Panel reconstructed by screen printing - detail

Proofs

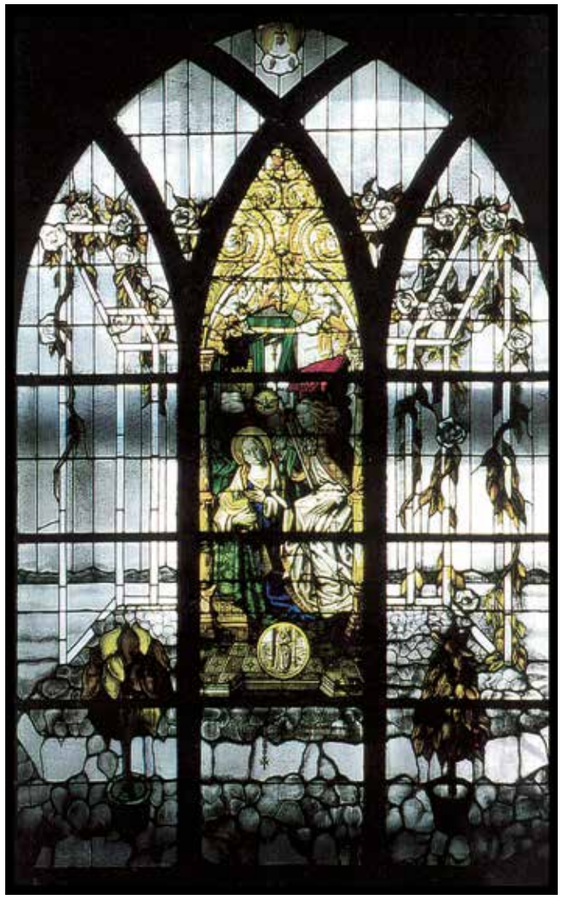


Original panels and additions mounted for colour matching

Original panels and additions after reinstallation



Windows in the 19th century with bull's eye glazing



Windows with artistic additions from the 1970s

Various grid samples on site

After the restoration

Restoration and lighting
The parish church of St. Peter in Cologne was built between 1513 and 1525 and contains a remarkable Renaissance cycle of stained glass windows, the remains of which have been preserved. The Renaissance windows date from 1528-1630.
A well-preserved inscription indicates the year and the donor: 1528, donated by Elisabeth, Countess of Manderscheidt. Parts of the collection are still preserved in the original. The framing bull's-eye glazing, which was still preserved in the 19th century, was not removed to safe storage during the war and consequently was destroyed.

The stained glass underwent various restorations over the course of time, but especially in the 19th century. In the 20th century, the entire lead matrix was renewed. In the 1970s, missing areas were supplemented with designs by various contemporary artists. Due to their intense and dominant design these additional panels compromised the visual impact of the Renaissance glass.

The special features of the painting technique
The masterly technical achievements of the period of their creation can be seen in the Renaissance panels. The finest grinding and engraving work can be found, the polished surfaces of which create brilliant light reflections. The filigree angel and dragon heads in the architectural frame also exhibit great skill. The multi-layered painting features fine contours, wafer-thin overlays and numerous different shades on the front and back. The traditional stained glass colours still in use today, such as black grisaille paint, silver stain and Jean-Cousin (skin colour), were used. The masterly workmanship is also reflected in the lead matrix.

The restoration
The restoration of the Renaissance glazing from August 2002 onwards was a demanding task for the qualified restorers. The wafer-thin original glass was prone to breakage due to its thinness, which explains the numerous distressed or cracked leads and the applied plating of earlier restorations.

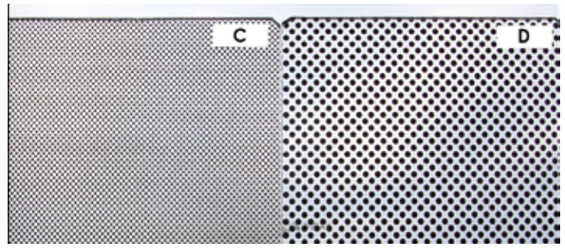
The visually intrusive mending leads and plates were carefully removed and the open cracked areas were edge-bonded with an appropriate epoxy resin adhesive (2 components) after careful cleaning.

After the restoration of the artistically impressive Renaissance panes, they were to become the centre of attention once more.

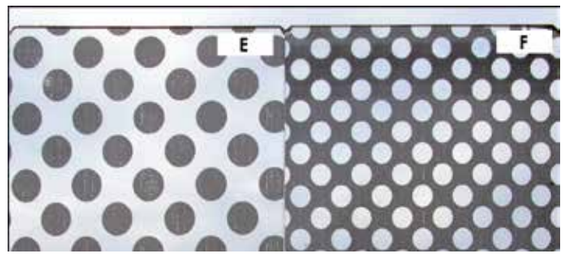
The intention was to achieve design clarity by dispensing with the 1970s supplementary panels. These were removed and stored in accordance with the conservation guidelines.

Another reason for these measures was that the church was also to be used as an exhibition space, so the interior needed to be given a calmer light. The newly created glass environment of the Renaissance fragments was darkened by means of screen printing discs in such a way that the middle grey value embeds the historical fragments in the overall picture without competing with them.

In March 2003, the reassembly began with the installation of the Crucifixion window. The parish church of St. Peter now has an artistically valuable and effective series of Renaissance windows again. The way in which the new supplementary panels were added corresponds to the overall concept of „restoring" the church with a special presentation of the historical components.



Grid samples in different sizes



Grid samples in different sizes

Berlin Cathedral

Reconstruction of the windows (1904 -1906) in screen printing on three pane levels.

were created between 1904 and 1906 to designs by Anton von Werner. At that time, they were executed in a special three-colour technique (Luce Floreo).

The entire glazing, as well as the dome of the Berlin Cathedral, was destroyed during the war. The reconstruction of the damaged building did not begin until 1975. The window glazing was reconstructed using a new technique in the workshop of the Peters company in Paderborn from 1991-1997, based on the existing design cartoons and a large number of photographs.

The Luce Floreo technique
The glass painter Richard Sander adopted the three-colour technique developed by the painter Otto Dillmann around 1895. Sander gave this technique the well-known name „Luce Floreo“ (I blossom through light). In his „Kunstanstalt für Freilichtmalerei“ in Barmen he produced, among other commissions, the glazing for the Berlin Cathedral.

The stained-glass windows, executed with this technique without painting, appear in transmitted light like oil paintings with the finest glazes. Three flashed glass panes in the primary colours red, blue and yellow were used to produce these windows. The designs were transferred to the glass by means of a multi-stage etching process.
Each pane received an individual treatment and was etched differently according to the optical colour mixture. Only by superimposing the three layers of colour, i.e. placing the panes one behind the other, did the actual picture emerge, which today is comparable to a multi-colour print.

The sculptural effect of the picture was further enhanced by the depth effect created by the three staggered layers of paint. Although unique works were created with this technique, detailed knowledge of its execution has not been handed down.

Construction in the workshop

Hand-painted with black grisaille paint, overlays and enamel colours

Raster print in three colours on three panes

Blue screen print

Yellow screen print

Red screen print

Pane structure

Possible variants for reconstruction
The aim of the window reconstruction was to restore the original, characteristic spatial effect of the cathedral without deceiving the viewer with copies. Different approaches to possible reconstruction were discussed and various technical variants were tested for their effect. Attempts were made to reconstruct the windows using the following techniques:

- Traditionally painted glass
- Etched flashed glass
- Glass with black and white screen printing
- Three panes of glass with coloured screen printing in 3 colours

The execution
The execution in colour print on three panes was the most satisfactory from an ethical, visual and technical point of view. The original cartoons of the windows served as a direct model, without demanding an artistic interpretation of their own.

The image was broken down into its three basic colours with the help of computer programmes. Then the three colours were screen-printed onto the three glass panels (2 mm). Fine-tuning of the size of the screen dots and the colour impression was carried out on sample panels. The screen should not be too fine, so that the copies are visible to the viewer as contemporary reconstructions.

However, too coarse a grid ran the risk of dissolving the effect of the picture. The window glazing should blend harmoniously into the architecture, completing the intact overall picture of the interior, but become recognisable to the viewer as a reconstruction when seen up close. In this way, it was possible to meet the demands of the preservation of historical monuments for a reconstruction that could be done ethically, and also the wishes of the church visitors for a coherent overall picture.

Choir after reconstruction

Grassi Museum for Applied Art, Leipzig

Reconstruction of the war-damaged staircase windows to designs by Josef Albers

Exterior view after reconstruction

The extensive main staircase of the Grassi Museum houses a unique work of modern art - the glass of the 18 large windows, up to 7 metres high. The designs for the strictly geometric compositions were provided in autumn 1926 by the painter, designer and art teacher Josef Albers, who worked at the Bauhaus in Dessau. The windows were executed and installed in March 1927 by the renowned Berlin stained-glass workshop Puhl & Wagner, G. Heinersdorff.

On the one hand, the windows were created as a contribution to the important in-house exhibition „European Decorative Arts 1927“, but at the same time they were also intended as a permanent architectural decoration. With them - the largest glass design of the Dessau Bauhaus period - they give convincing expression to the museum‘s commitment to the artistic avant-garde at a central point. Albers‘ room-enclosing compositions in the „thermometer style“ create a connection between the individual storeys of the museum, guiding the visitor from the ground floor to the upper collection rooms. Although they cannot be viewed in their entirety from any point inside, they have the effect of a large, structured, yet coherent, mysteriously luminous abstract image that only becomes fully apparent when in motion, and whose ordered, premeditated beauty can be constantly experienced differently in the changing light. During the bombing raid on Leipzig on the night of 4 December 1943, the windows were severely damaged. Further destruction and ultimately total loss followed until 1945, after which the Josef Albers windows were considered lost for decades. In 1996, museum research revealed that the 1:1 scale drawings and photographs of the designs still existed. The desire for a reconstruction was expressed. In 2006, following a publication about the windows, the Grassimuseum für Angewandte Kunst launched a fundraising campaign to qualify and advance the project with the incoming funds. All available drawings, designs and historical photographs were photogrammetrically processed and assembled into a puzzle-like sequence. This created the documentary basis for all further steps.

In 2008, we had our first meeting with Prof. Christine Triebsch of the Burg Giebichenstein Art Academy in Halle and our workshop and began to deal intensively with the artistic and technical questions of the reconstruction. Christine Triebsch analysed the structure of the windows in detail.

In 2009, the first trial panels were commissioned. Oliver Barker, project director of the Josef & Anni Albers Foundation (USA), examined these as well as others and subsequently realized them together with those responsible for the project at the museum.

In 2010, the preparatory work had progressed so far that an application for funding for the reconstruction could be submitted to the Ostdeutsche Sparkassenstiftung and the Sparkasse Leipzig. They handed over the official funding decision in April 2011. Subsequently, the owners‘ association of the Grassimuseum agreed to the reconstruction, so the actual restoration with the traditional techniques could begin. The opal and opaque glasses used were specially made by Hütte Lamberts and partially painted on both sides with black grisaille paint to create different exterior and interior effects. The wedge cuts, 4,419 in all, were

Interior view after reconstruction

finished by hand with five different grinding and polishing wheels. The glasses were then joined together with lead cames of different thicknesses, soldered and cemented with linseed oil putty from both sides.
In order not to detract from the special exterior view, which was precisely planned by Josef Albers, the exterior protective glazing common today was dispensed with. Instead, insulating glazing was installed in front of the windows on the interior side, which, however, does not detract from the interior view of the windows in transmitted light.

Interior view after reconstruction

Protective glazing
Principle and effect

Stained glass windows are a special form of cultural asset because, unlike a painting, for example, they also fulfil a constructive task on the building and are artistically designed.

However, it is precisely this function of the window as a barrier between the outside and inside climate that is often the undoing of stained glass. If it cools down outside and the interior air carries sufficient moisture, the painted interior window surface falls below the dew point and condensation forms. The condensate has the ability to attack the glass and paint, which can increase in combination with dirt on the surface. Corrosion can also occur on the outside due to weather influences.

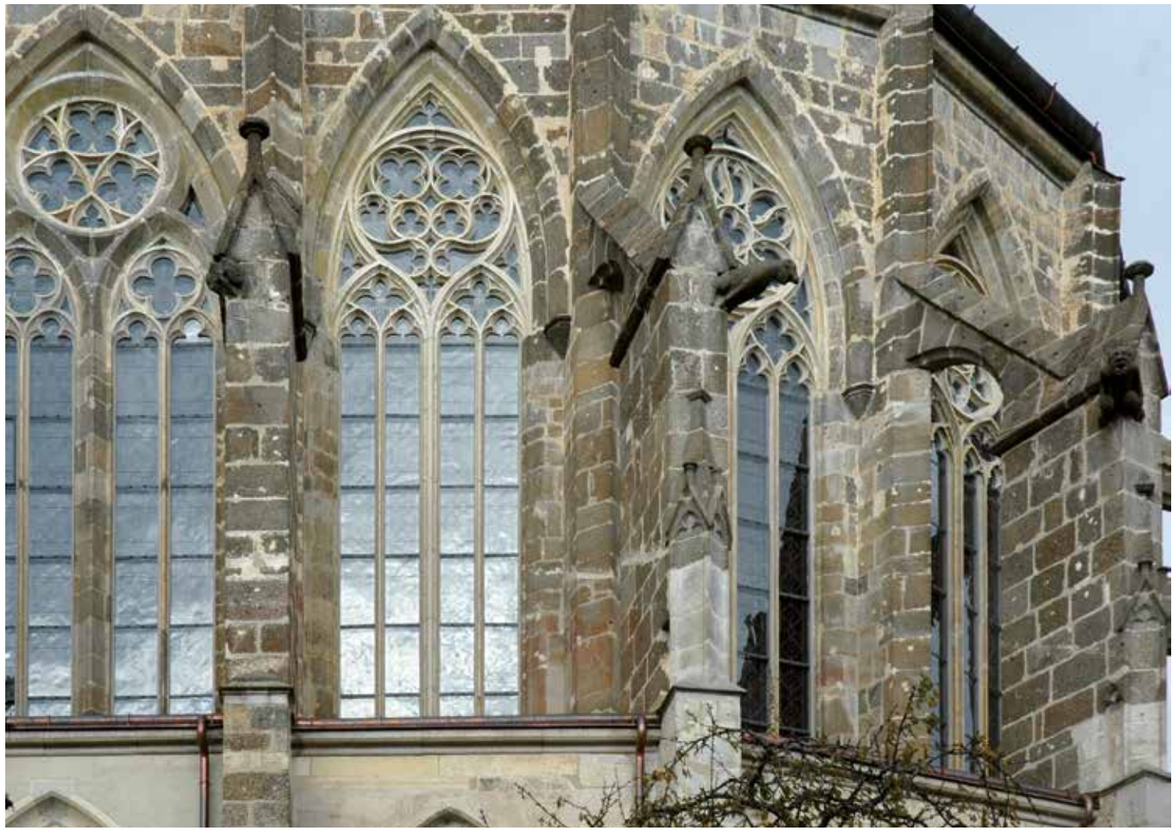
Glass components or components of the painting layer are leached out, gaps appear in the structure, the material becomes more porous and hydrolytic decomposition is accelerated in the future. In short: the glass and the painting are destroyed. As a result, compact deposits of corrosion products lie on the glass, clouding it and even darkening it completely and layers of painting fade, dissolve or are lost completely.

It is still possible to present the stained glass in its existing place. However, an intervention is necessary to move the stained glass from the exterior, where it is exposed to the weather, to the interior of the church and to install so-called protective glazing. This is located on the outer window plane and henceforth has the function of a weather shield; in future, condensation will form here. The stained glass is mounted a few centimetres into the interior of the church in front of the protective glazing. Extensive scientific research has proven the effectiveness of protective glazing, and the viewer hardly notices any change when looking at it from the inside.

However, notwithstanding the benefits of protective glazing for the preservation of valuable stained glass, the impression made when looking at the building from the outside changes. Through years of experience, we have developed a diverse range of protective glazing types, so that there is something for every requirement. In addition to providing corrosion protection, protective glazing can also provide protection against vandalism and further soiling. Furthermore, protective glazing is available in a wide variety of appearances and designs, for example toughened safety glass, laminated safety glass or insulating glazing with anti-reflective, undulating, kiln-formed or doped surfaces.

The adaptation and modification of the installation of the window as well as the preparation of the panels for the planned protective glazing and the production of various condensate collection channels and drainage systems are naturally also part of our remit. Protective glazing is currently the ideal solution for the museum presentation of fragile stained glass in its installation location from a monument preservation point of view.

There are various approaches for monitoring the functional efficiency of protective glazing. However, these are often associated with additional financial burden, scaffolding, surface-mounted cables and personnel-intensive evaluation, or are only possible at certain points and thus not representative. For this reason, protective glazing is installed, but its functionality is usually not monitored further.



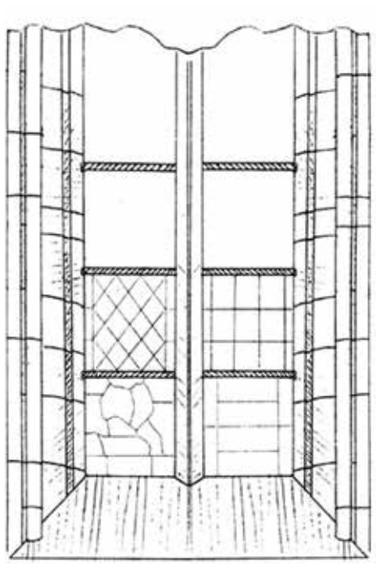
Exterior view of kiln-formed protective glazing

original condition

all over

Pointed diamond- and rectangular division

free eon pitch, lead net division picked up



original condition

all over

Pointed diamond- and rectangular division

free eon pitch, lead net division picked up

Test panels of this window side in float glass

Test panels of this window side in grained raw glass

Samples of various types of protective glazing

Slightly distorted reflection

Closure of the building envelope by the protective glazing - the art glazing is simply placed in front from the inside after restoration.

Protective glazing sensor system Custos Aeris

Sensor system for contact-free climate monitoring of stained glass, wall paintings and historical cultural assets

In order to protect valuable historical stained glass, it is often provided with protective glazing during restoration.

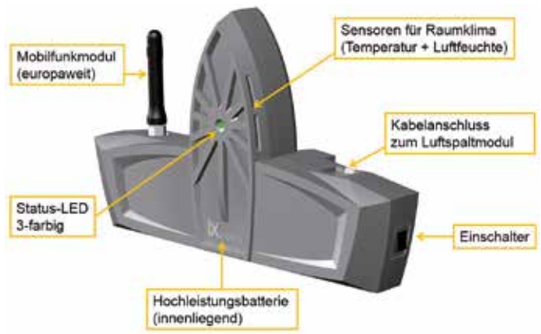
The microclimate (humidity, temperature) in the interspace between the protective glazing and the stained glass is regulated by the exchange of air with the interior of the building. Effective ventilation of the interspace depends on numerous factors such as climatic conditions, installation situation, interspace depth, etc. Random measurements of climatic parameters are not sufficient to assess the functional efficiency of protective glazing. In order to record representative values, long-term measurements are indispensable.

As part of an innovative project funded by the Deutsche Bundesstiftung Umwelt (DBU), a non-contact and energy-autonomous sensor system for continuous monitoring of the functionality of protective glazing was successfully developed together with the Paderborn-based high-tech company iXtronics GmbH.

The sensor system records climate data in the interspace between the protective glazing and the stained glass as well as in the interior of the church, which is necessary to monitor the functionality of the protective glazing. The measurement data is recorded for at least an entire calendar year and transmitted daily via the mobile phone network to a password-protected internet platform. All data is automatically processed and made available in the form of clear diagrams which can be accessed anywhere in the world via an Internet browser.

The sensor system offers the following range of functions:

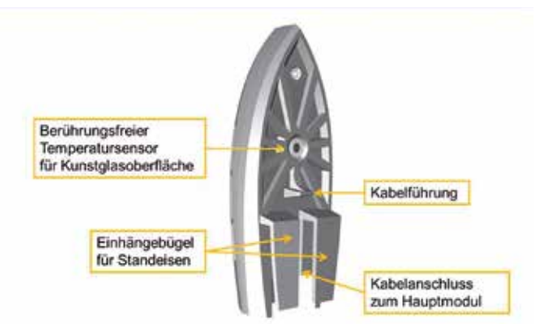
- Non-contact monitoring (no need to glue on sensors)
- Automatic calculation and monitoring of all dew point limits
- Direct visualisation of all measurement data in the internet browser
- Contact-free measurement of glass surface temperatures (protective glazing, stained glass in the interspace, stained glass in the interior)
- Non-contact measurement of wall temperature
- Emission levels of the surfaces to be measured freely adjustable
- Measurement of relative humidity and temperature in the interspace and the interior
- Measuring range: -20°C to 85°C, measuring accuracy > 99.5
- Measurement data acquisition at 15-minute intervals
- Daily transmission of measurement data to the secure web server via the mobile phone network Europe-wide (no WLAN required)
- All measurement data can be downloaded as a CSV file
- Energy self-sufficient for at least one year
- Simple plug & play installation (no configuration required)



Main sensor module (front)

Main sensor module (back)

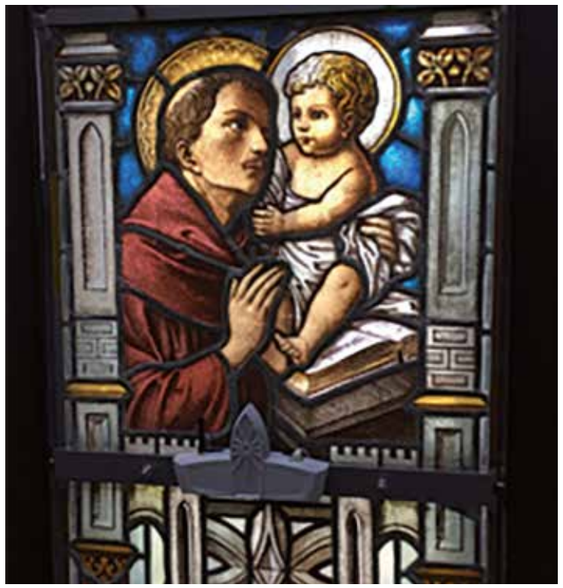
Luftspaltmodul (Vorderseite)



Interspace module (rear)

Due to its contact-free measurements, the sensor system is also excellently suited to wall paintings and other historic cultural assets (organs, paintings, sculptures, etc.).
Leading cathedral building lodges (including Cologne, Soest and York), restoration workshops, engineering offices and architects are already using the non-contact sensor system.

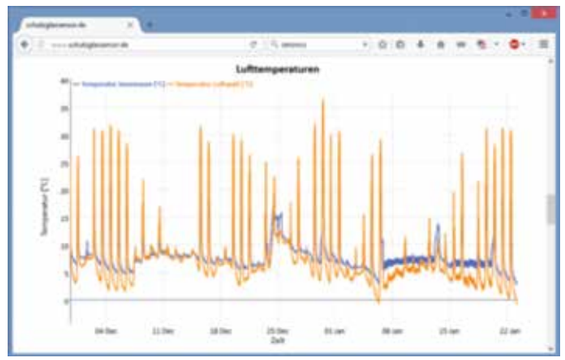
Further information on the sensor system can be found on the Internet: **www.custos-aeris.de.**



Installation situation main module

Installation situation interspace module

Measurement data diagrams in the Internet portal



The sensor system is optimally adapted to the structural and climatic conditions of protective glazing.

Dalle de Verre window restoration

A new speciality

Dalle de Verre windows form an absolute speciality in the field of stained glass. The art of setting thick pieces of glass into concrete developed at the turn of the 20th century.
Originally intended to illuminate basements by means of pavements, this process was very quickly adapted to the design of window walls.

After the Second World War, this window form became the focus of architects' attention and found its heyday in the years that followed. There is hardly any other type of window design that is so closely linked to architecture as Dalle de Verre windows.

The combination of glass, concrete and steel develops its own artistic quality through the formation of concrete and glass reliefs on the inside and outside as well as its special colour effects, which the thick glass creates by its light refraction.

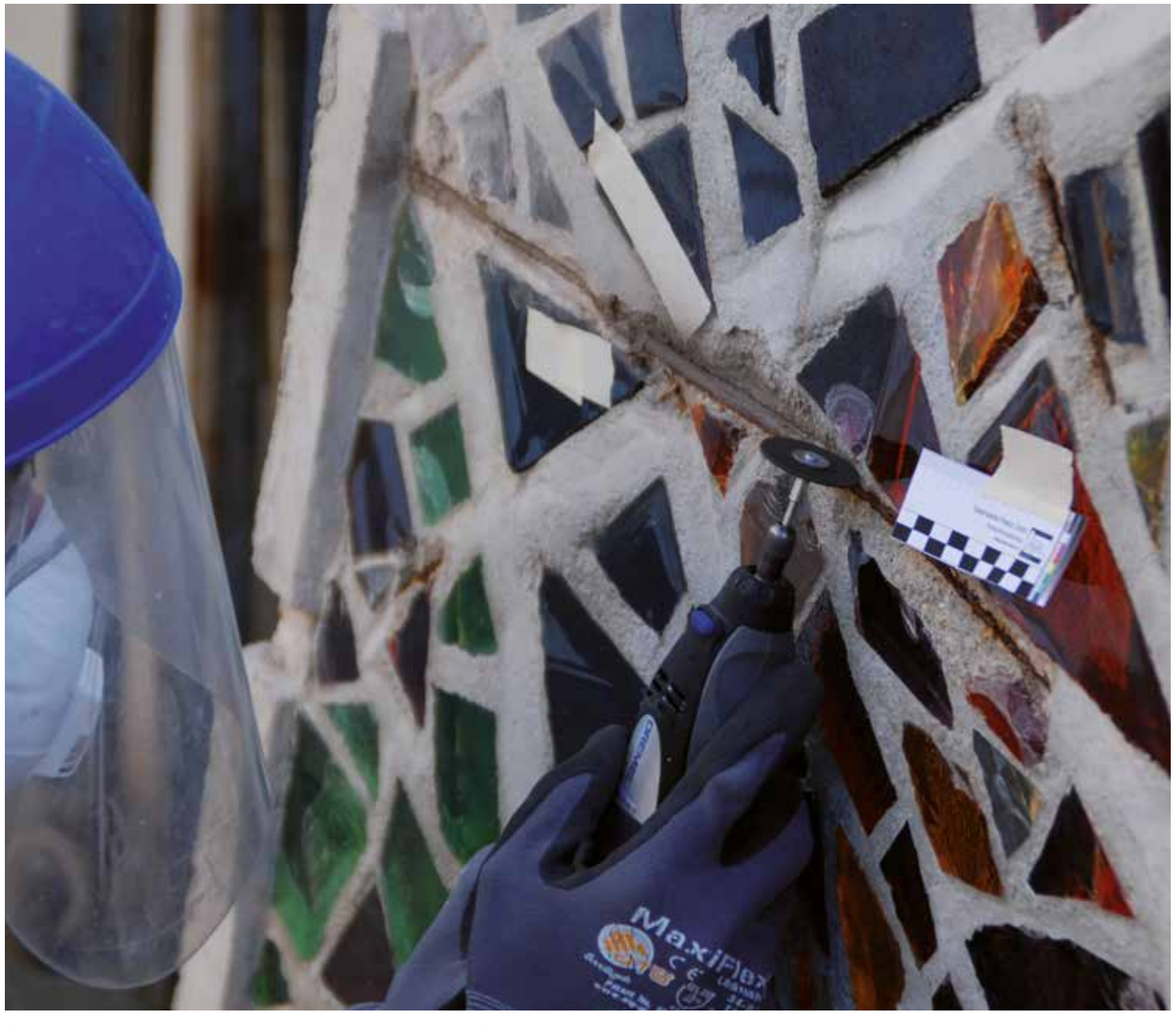
Their ageing and corrosion processes also differ significantly from those of traditional leaded glass. As early as 2009, we conducted the first research project in the field together with the „Bundesanstalt für Materialforschung" (Federal Institute for Materials Research) and have been constantly developing the restoration techniques ever since. Two subsequent research projects and numerous restoration works brought further important findings. With the skills we have acquired, we can carry out an exact analysis of the condition of Dalle de Verre windows and consequently recommend necessary measures or an individual restoration concept.

In recent years, we have been able to restore and preserve more than 30 major Dalle de Verre window cycles. We will not let up in our fight to preserve this extraordinary genre of art for the future.

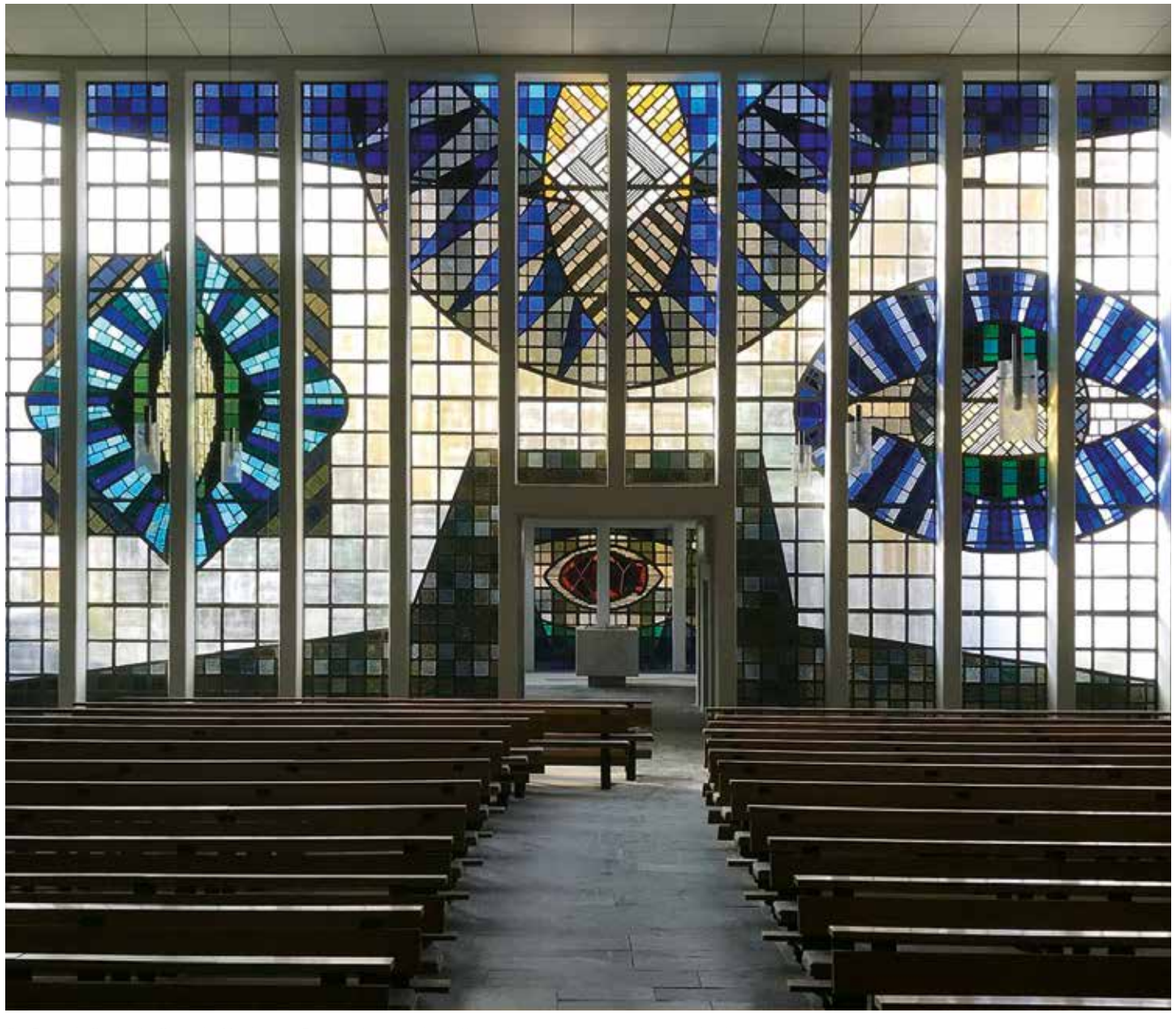
In doing so, we use a variety of restoration methods. From simple repairs to Dalle de Verre windows damaged by vandalism on site to the dismantling and complete overhaul of the windows in the workshop and the subsequent reinstallation and renewal of all sealing rebates, we now have a wide range of technical skills at our disposal.

Protecting the windows with a cathodic corrosion protection system is also part of our restoration expertise. We are constantly working on optimising and improving the existing restoration techniques.

Chipped glass surface



Exposure of the corroded reinforcement bars - Neustadt am Rennsteig



St. Peter's Catholic Church, Herborn - Restoration and additional conservation with a cathodic corrosion protection system

Mosaic restoration

Mosaics have been found in a variety of cultures for thousands of years and have changed over the course of time, both in materials and technique as well as in appearance, style and subject matter.

Mosaics were particularly widespread in the Roman Empire. Many floors, but also sometimes walls in residential buildings of an upper social class were decorated with mosaics.

In the first century AD, black and white mosaics were particularly popular, with geometric motifs predominating. Figurative depictions were rather rare and only became more popular in the second century.

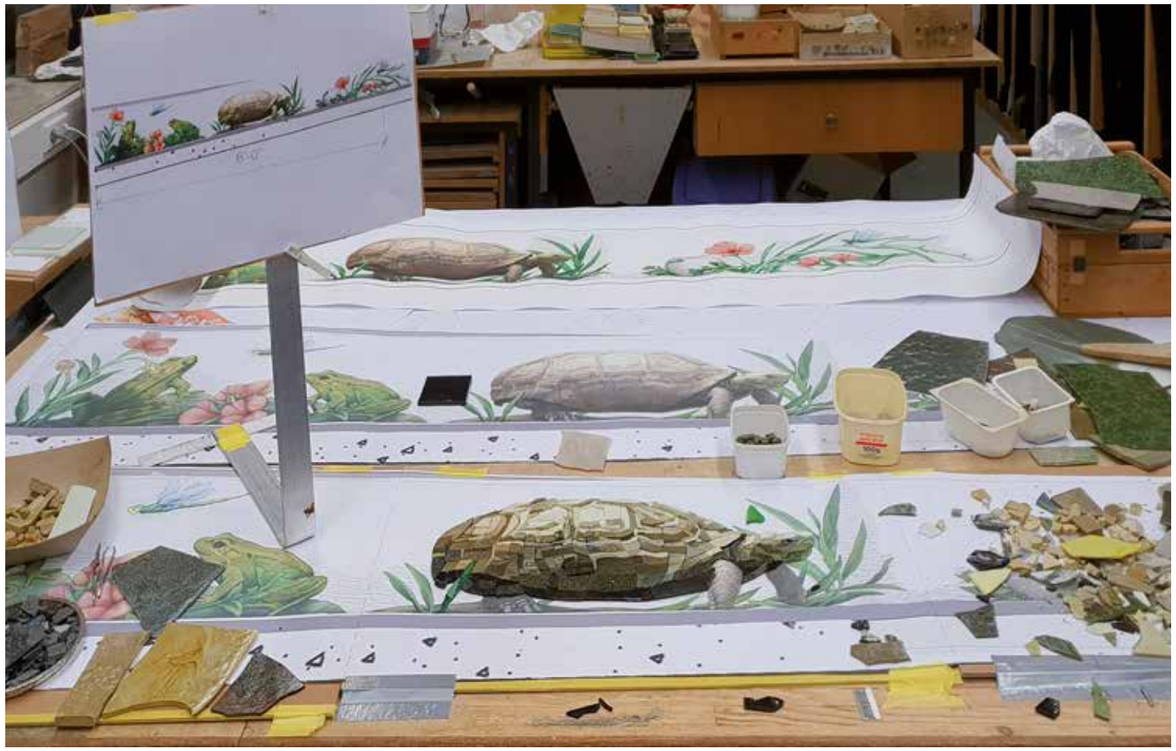
From the second century onwards, multi-coloured mosaics appear again, which were particularly popular in the African provinces and show a style of their own. In the east of the empire, classical Greek style elements and traditions predominate.

In the 19th century, with the return to old models, mosaics experienced a renaissance. Mosaics decorated with rich gold were particularly in demand to create historicist-Romanesque choirs. Today, large areas or individual stones are partially lost, making the overall picture difficult to read. As a result, the spatial impression desired originally is severely impaired.

For the restoration of historic mosaics, our workshop with its qualified restorers and the corresponding stock of mosaic materials from various historical epochs offers the ideal basis.

Damaged mosaic

Mosaic sample tesserae



Mosaic for Santa Clara High School designed by artist Lynn Goodpasture

Mosaic in the Cath. Church of Oberperfuss, Austria

Restoration of the wall mosaic in the Catholic Church in Oberperfuss, Austria

Defective areas

Glass mosaic made of hand-painted glass blocks for the Episcopal Church of Saint Barnabas on the desert, Scottsdale, USA - Artist: Sarah Hall

Art transport

We have made it our business to carefully transport your cultural property, when it needs to be removed and transported to the workshop for conservation, as well as to transport selected exhibits from all over the world. For the transport of your goods, we only use specially trained personnel who pack the goods carefully and without shock.

Packaging media specially tailored to the artwork are also provided or specially made for this purpose. For the duration of the transport, the artworks are equipped with exemplary data loggers to ensure and monitor the quality of the transport and the safety of the art object.

In Europe, we usually transport the valuable goods ourselves with our specially equipped vehicles.

For worldwide transports, we work together with renowned specialist art transport companies, which then take over the onward transport. In this context, we also offer courier services for shorter distances.

Transport of the historic windows of Shrewsbury Cathedral, UK

Transport crates specially made for the project

Securely packed

Exhibition concept and set-up

Setting up an exhibition in Altenberg near Cologne

An exhibition should leave an inspiring and lasting impression on visitors. In order to meet these demands, it is necessary to find technical solutions that secure the artworks and protect them in accordance with insurance requirements, but also do not conflict with the design demands and concepts of the exhibition as a whole.

After extensive consultation, we develop a technical presentation concept tailored to your exhibition that integrates into the premises and highlights the exhibit.

Not only the development, but also the technical support of the exhibition is part of our service. Preparation, assembly and installation of the exhibits are carried out by specially trained staff.

Restoration of vessels

Preparation of areas to be glued

Filling in the adhesive

Hollow glass, as well as small ceramics and lamp glasses, can also be restored and conserved by our specialist staff. Historical vessels from collections and archaeological excavations must be permanently secured and conserved. Here it is necessary to go into the third dimension.

The conservation of these glass vessels confronts our conservators with a completely different set of challenges, as the damage here is sometimes more strongly related to the mixing and production technique, or to the special storage of the objects in showcases or in the ground.

Here, a detailed analysis of the damage is indispensable. Thanks to our technical equipment and qualified staff, however, we are able to take on any challenge.

Retouching the bonding with the help of magnifying glasses

People‘s need to combine architecture with art is ancient and begins with cave paintings. In the field of sacred architecture, stained glass has for centuries documented people‘s need to enhance the effect of sacred spaces through works of art.

This primal need has survived to this day and continues to motivate artists and builders to enrich architecture with contemporary works of art. They manage to touch us deep inside. Stained glass, which can produce coloured, mystical light, plays a major role in this and has the ability to address our subconscious in a special way.

We are happy to make our contribution to the care and sustainability of architectural monuments through the preservation of historical stained glass, as well as through the creation of new contemporary works of art, together with artists and architects.

The selection of the artist is of great importance for the success of such a project. In addition, it is essential that the artist is particularly sensitive to the architecture and the existing works of art and that his or her work is integrated into the larger whole. With all our experience, we will be happy to advise you and bring client and artist together.

Exterior view of Großbadegast Evangelical Lutheran Church 2019

Before the reordering - Großbadegast Ev.- Lutheran Church 2019

Animation by DS Architects, Köthe Großbadegast Ev.- Lutheran Church with designs by Tony Cragg

Without many words we illustrate three outstanding projects where we have introduced contemporary stained glass into listed buildings: Großbadegast, Zerbst and Oberperfuss.

St. Bartholomew‘s Lutheran Church, Zerbst before and after the installation of the choir windows - Artist: Jochem Poensgen - executed in 2018.

The choir windows for the parish church in Oberperfuss, Austria according to designs by Wilhelm Scherübl – executed in 2018.

References (selection)

Medieval stained glass windows:

Altenberg, St. Maria (Cathedral), 12th - 14th c. (pages 8,9)
Cathedral Notre-Dame-de-Chartres (F), 13th c. (pages 12-15)
Cervera, (ESP), St. Maria, 14th c.
Freiburg, Cathedral of Our Lady, 16th c.
Ingelheim, ev. castle church, 15th c.
Cologne, St. Peter, 16th c. (pages 28, 29)
Cologne, St. Pantaleon, 16th c.
Selles, (F), St. Denis, 16th c.
Seville, (ESP), Cathedral, 15th c. (pages 16,17)
Soest, St. Maria zur Wiese, 16th c.
Soest, St. Petri, 13th c.
Straubing, St. Jakob, 15th c. (pages 10,11)

Baroque stained glass windows:

Abtenau, Kath. church, 18th c.
Antwerp, (B), Sterckshof, 18th c.
Boitzenburg, catholic church, 17th c.
Franciscan monastery Rietberg, cloister, 17th - 18th c.
Girona, (ESP), Cathedral, 17th c. (pages 18,19)
Munich, Theatinerkirche, 17th c.
Paderborn, Cathedral, 18th c.
Salzburg, (A), collegiate church, 18th c.
Erbach Castle, 17th c.
Harkotten Castle, Münsterland, 17th c.

19th century and early 20th century:

Bruges, (B), Cathedral, c. 1900
Hamburg, St. Petri, around 1880
Hamont Achel, (B), Sint Laurentiuskerk, around 1890
Hildesheim, Cathedral, after 1900
Kuringen, (B), St. Gertrudis, around 1900 (pages 20, 21)
Limburg, (NL), town church, around 1900
Lüdinghausen, St. Felizitas, around 1860
Erbach Castle, around 1860
Manresa, (ESP), Cathedral, around 1870
Naßstädten, St. Peter and Paul, around 1860
Paris Vanves, (F), St. Rémy, around 1880
Scherpenheuvel, (B), Church „Our Lady“, around 1840
Straubing, St. Jakob, around 1890 to 1908
Vught, (B), Petruskerk, after 1900
Warendorf, St. Laurentius, around 1880 to 1900

After 1945

Beringen, (B), S. Theodaruskerk, concrete glass window
Düsseldorf, St. Martin
Hamburg, St. Marien (Cathedral), Schreiter window
Stadtallendorf, catholic church
Wittlich, St. Markus, Meistermann window
Würzburg, Sepultur, Meistermann window

Museums:

Amsterdam, (NL), Imperial Museum,19th c.
Brussels, (B), BOZAR, reconstruction
Freiburg, Augustinermuseum, reconstruction (pages 26, 27)
Hanover, Museum Kestner, 13th - 16th c.
Izegem, (B), Epron D’or, reconstruction
Cologne, Museum Schnütgen,14th - 19th c.
Ostend, (B), Oide Port, reconstruction.

Reconstructions:

Berlin, Cathedral (page 30, 31)
Landeck, Church of the Virgin Mary (pages 22-25)
Leipzig, Grassi Museum (pages 32, 33)
Paderborn, Abdinghof Church

Concrete thick glass restoration:

Alzey, catholic church
Borken, Church of Christ the King
Canterbury, (UK), Cathedral
Flörsheim, catholic church
Hamburg, ev. ref. church
Hamburg, Wilhelmsburg
Hamburg-Barmbeck, Lutheran Church
Herborn, St. Peter‘s Catholic Church (page 39)
Künzelsau, St. Paul‘s Church
Limburg, Marienschule
Neustadt am Rennweg, St. Michael‘s Church
Osnabrück, Melanchthon Church
Spiekeroog, Lutheran Church
Weilburg, catholic church Heilig Kreuz

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