

(a) Recent Image (main information)



(b) Old image (side information)



(c) Registered old image



(d) Inpainted Image

Virtual Restoration of Stained-Glass Windows

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Nicolas Gillis, Saïd Mahmoudi.

IRPA KIK Royal Institute for Cultural Heritage
GHENT UNIVERSITY
UMONS University of Mons
belspo .be

1.
St. Martin’s Basilica
on the Publémont hill
in the city centre of Liège,
Belgium





Liège, stained-glass windows in the choir of St. Martin's Basilica (*ca* 1527)



Liège, St. Martin’s Basilica, eastern face of the south arm of the transept



Stained-glass windows of the north and south arms of the transept: a. Virgin and Child, b. Alms of Saint Martin, c. stained-glass window of Arnold de Bocholtz, d. stained-glass window of Conrard de Gavre. Photomontage









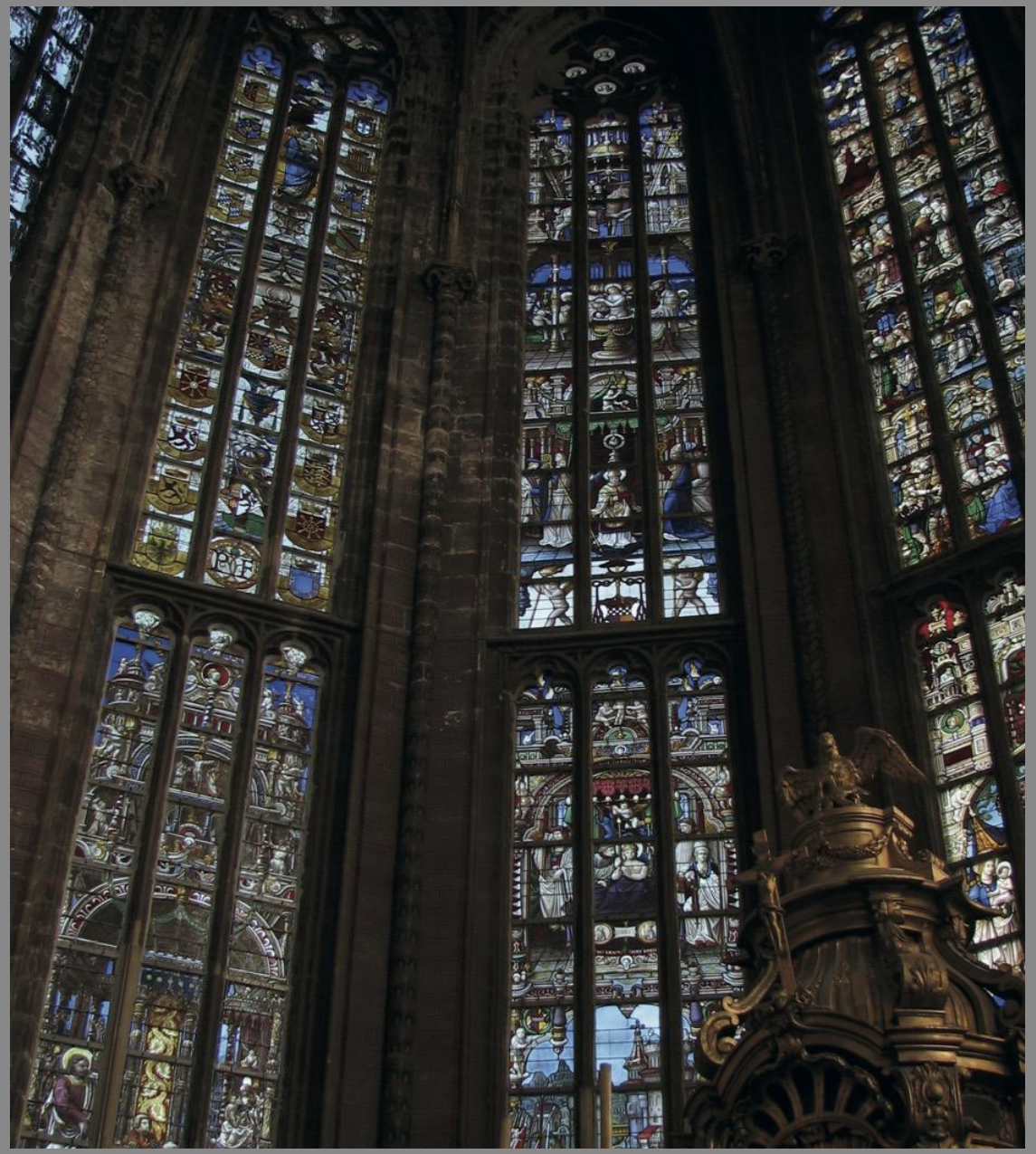








Liège, St. Martin’s Basilica



Liège, stained-glass windows in the choir of St. Martin's Basilica (*ca* 1527)



Stained-glass windows of the north and south arms of the transept: a. Virgin and Child (1575-1590), b. Alms of Saint Martin (1575-1590), c. stained-glass window of Arnold de Bocholtz (after 1568), d. stained-glass window of Conrard de Gavre (1569-1584). Photomontage



Colourless and coloured glass painted with grisaille and highlighted with silver stain



Colourless glass painted with grisaille



Colourless glass painted with grisaille and highlighted with silver stain



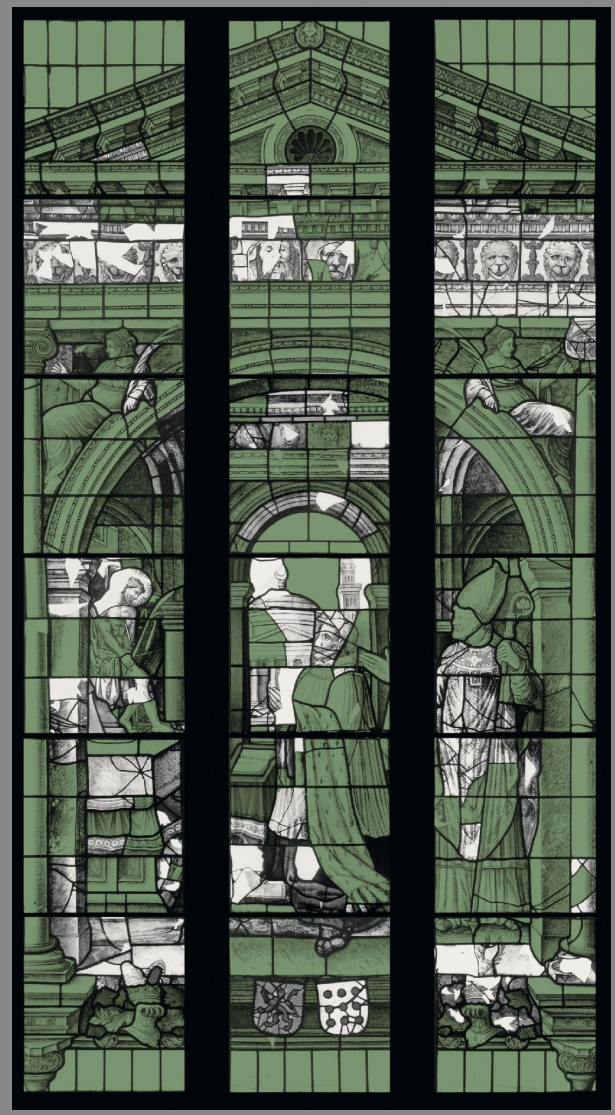
Stained-glass window of the Virgin and Child. State of conservation.



Stained-glass window of Saint Martin giving alms. State of conservation.



Stained-glass window with Virgin and Child, donor and Saint Martin. State of conservation.



Stained-glass window with Christ, donor and Saint Lambert. State of conservation.



Repaired pieces of glass with mending leads













LA LANTERNE

QUOTIDIEN D'UNION NATIONALE ET DE SOLIDARITE INTERNATIONALE

1e ANNEE. — N° 154. — 2 Fr. — En France : 4 Fr. BRUXELLES JEUDI 4 JUILLET 1946.

Ne gaspillez pas le Pain ! C'est votre tartine de demain...

DECLARATION DE L'AMBASSADEUR RUSSE A WASHINGTON

Rien ne justifie une guerre entre l'U. R. S. S. et les E.-U.

« Les choses qui nous séparent doivent être réglées, et je crois qu'elles le seront »

Par Graham Hovey, correspondant de l'A. P.

La Terre Promise

L'interpellation Rolin au Sénat

LA CRISE EST CONJUREE

Les trois Partis de la Majorité ont déposé un ordre du jour commun

OPINIONS

ETAT D'ALERTE AU SIAM

Un projet du Comité hébreu de libération

Créera-t-on une République en Terre Sainte ?

(Par JORRY KORN, correspondant de l'Associated Press.)

WASHINGTON, 3 juillet.

LES ITALIENS OUBLIENT...

LA SITUATION INTERNATIONALE ET POTSDAM ?

Fin des grèves

MISS CINEMA

On y danse On y danse

Le gouvernement polonais l'emporte

59 NAVIRES ENDOMMAGES A BIKINI

Le Duc de Windsor vend ses cigarettes

UNE CHARTE ATOMIQUE

Pas de soldats américains en Palestine

Scepticisme russe

4,500 tonnes de beurre néo-zélandais pour les Etats-Unis

Le programme économique italien

Les trotskystes protestent

L'Intelligence Service en Palestine

Une protestation aux Quatre

L'internationalisation de Trieste

Une République en Terre Sainte

Un violent orage sur Liège

Le référendum aux trois questions

AUX QUATRE COINS DU MONDE

PARIS

LA HAYE

BERNE

LONDRES

HAMBOURG

DUSSELDORF

BERLIN

ROME

VARESE

L'U. I. R. collaborera avec l'O. I. R.

DERNIERE MINUTE

Sécurité

Un violent orage sur Liège

Un orage d'une extrême violence s'est abattu hier soir sur la région liégeoise. La grêle est tombée dans toute la vallée, provoquant outre des inondations de rues et de caves, des dégâts aux cultures et dans la région fruitière de Basse-Meuse.

La Lanterne, 4 Jul. 1946, p. 1







Broken pieces of glass with breaks and losses


CAISSE 19
CAISSE 20
CAISSE 21
CAISSE 22
F11

Isabelle Lecocq, *Les vitraux de la seconde moitié du XVIe siècle et de la première moitié du XVIIe siècle conservés en Belgique: provinces du Brabant Wallon, de Hainaut, de Liège et de Namur* (Corpus Vitrearum Belgium, vol. 6), Turnhout: Brepols, 2011





Stained-glass window of the Virgin and Child. State of conservation.



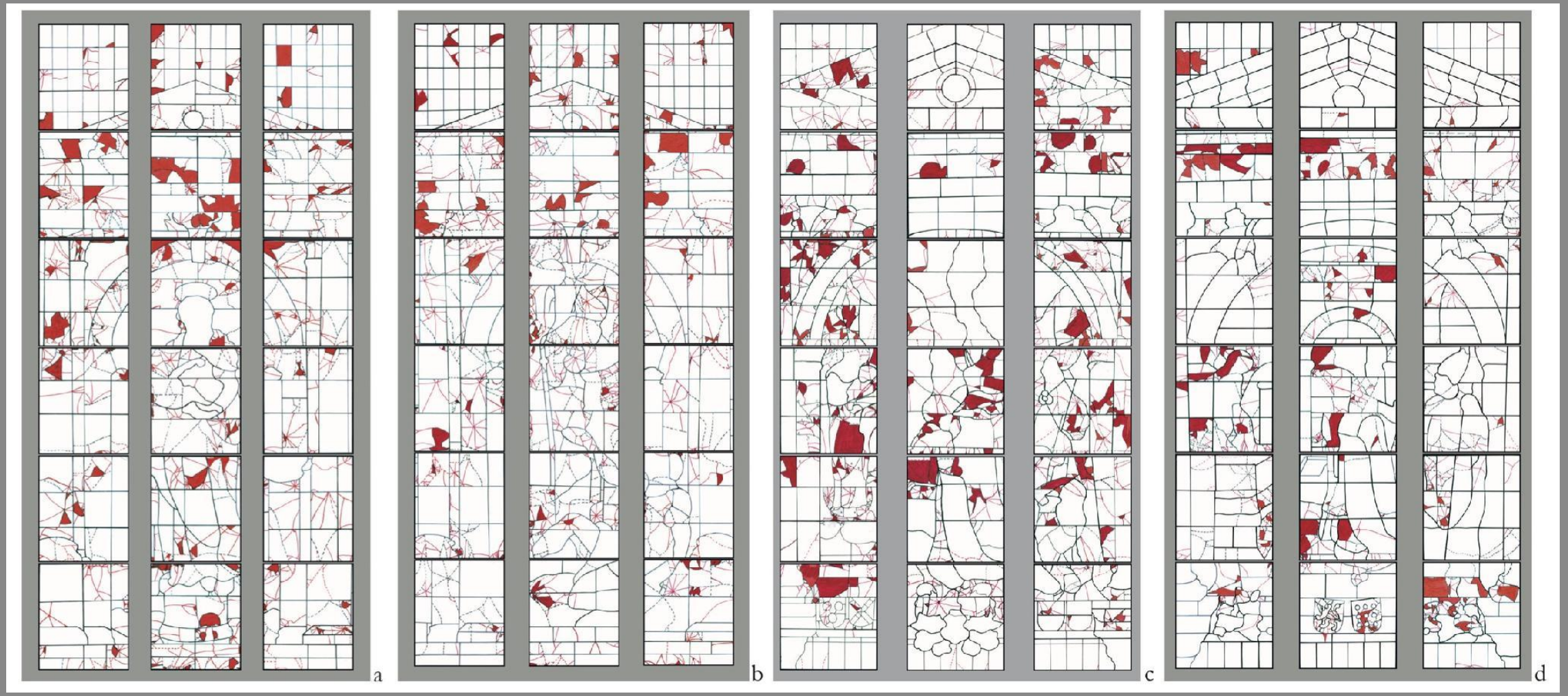
Stained-glass window of Saint Martin giving alms. State of conservation.



Stained-glass window with Virgin and Child, donor and Saint Martin. State of conservation.



Stained-glass window with Christ, donor and Saint Lambert. State of conservation.



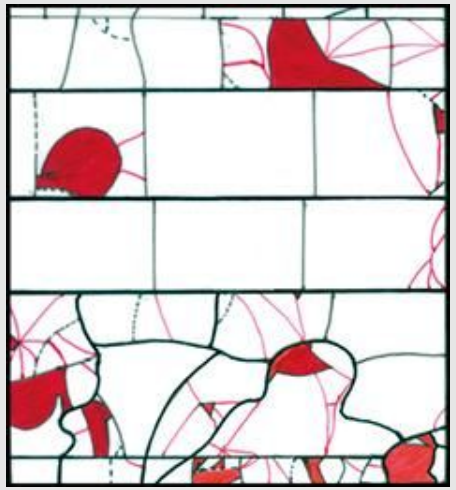
Record of damage to the four historic stained-glass windows in the transept (1998):
a. Virgin and Child, b. Alms of Saint Martin, c. Arnold de Bocholtz window, d. Conrard de Gavre window.

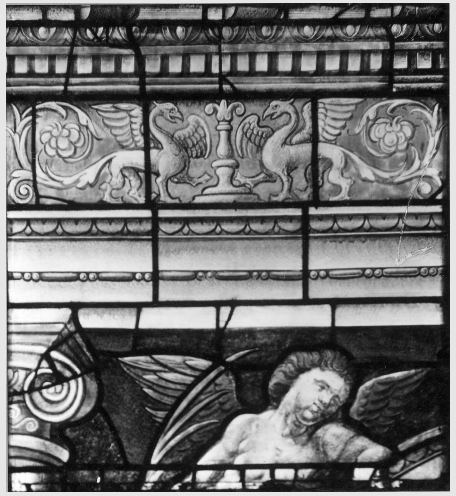




2.
Virtual restoration









A transdisciplinary project

- With 14 students in computer science (University of Mons, Belgium)







3 main steps

Image registration



Damage detection



Inpainting (virtual restoration)

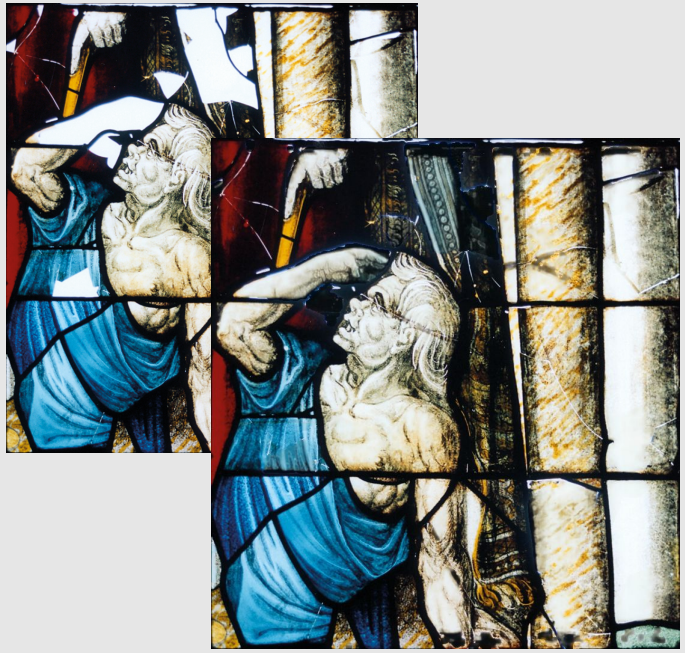
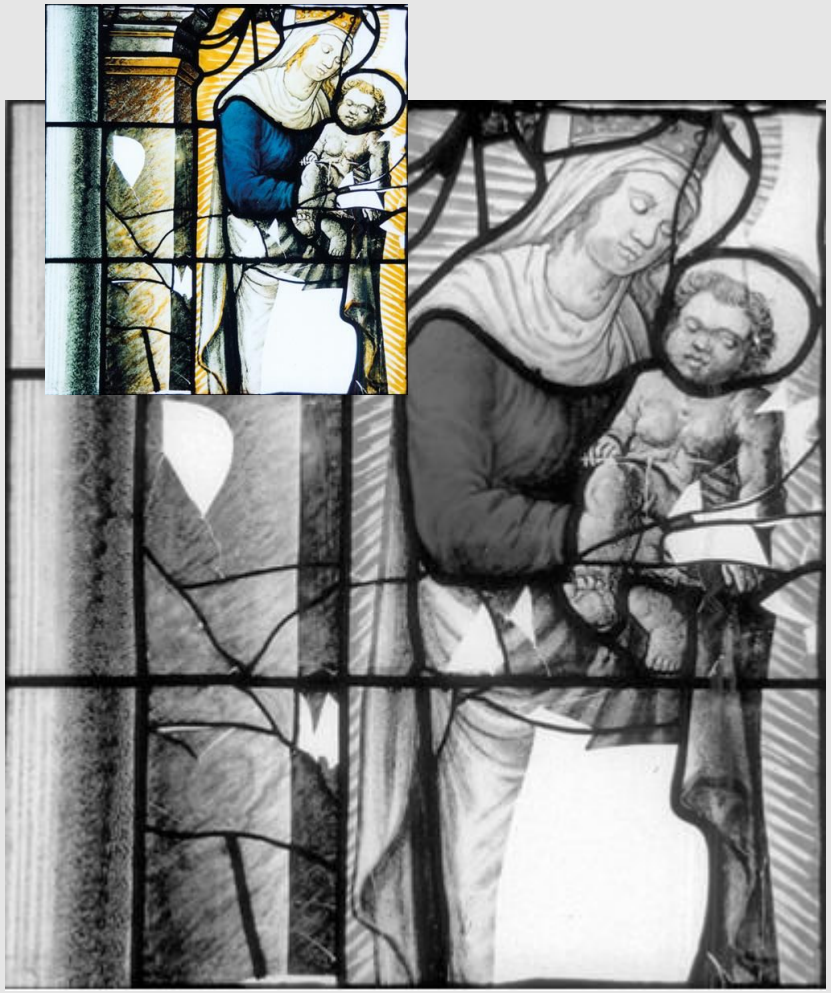


Image registration: aligning images of the same section



Color image converted to grayscale



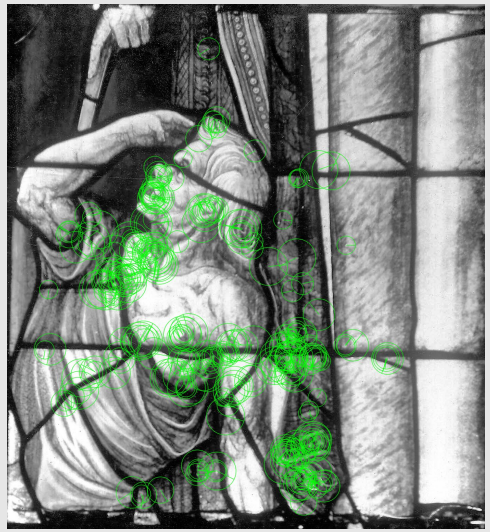
Original grayscale image



Registered grayscale image

Image registration

Detect anchor points (ORB features)

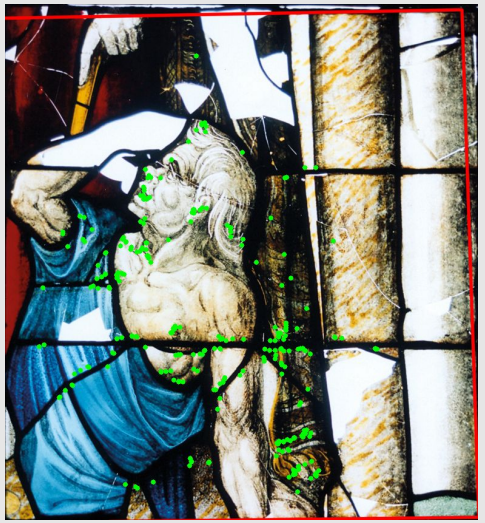




Match anchor points



Estimate deformation (homography)



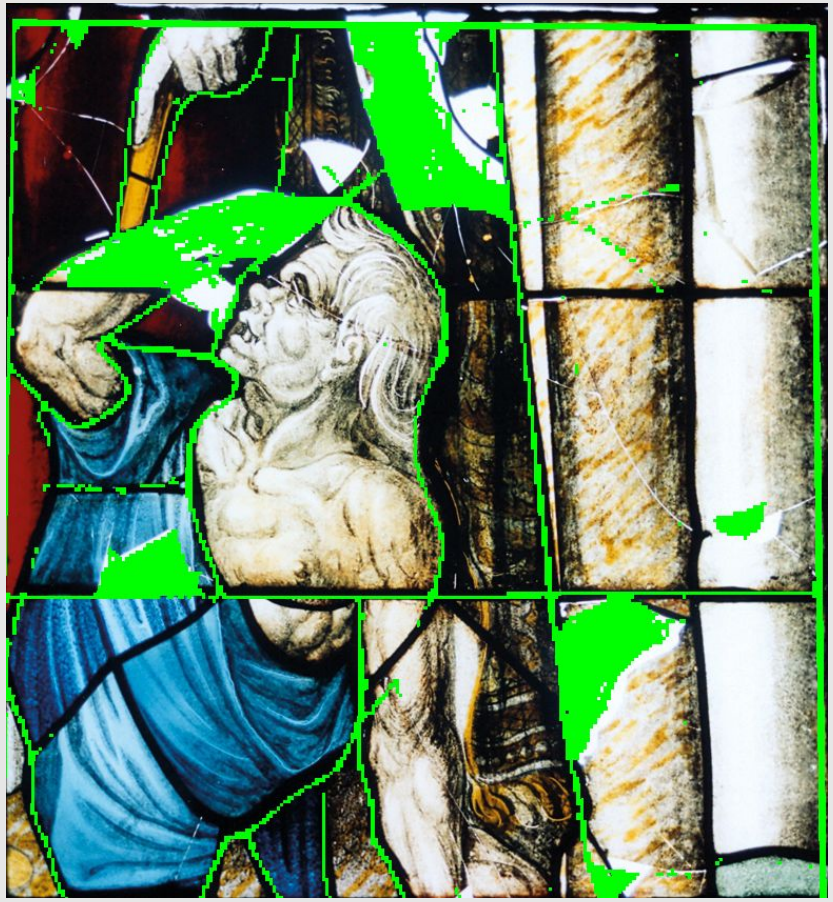
Result (overlay)



Damage mask extraction from manual annotation









Damage mask detection from the data





1st method: luminance difference





2nd method: white areas detection



Fusion (intersection)

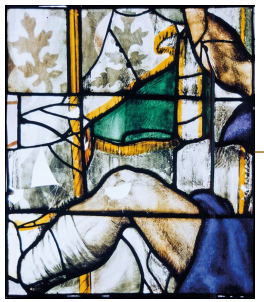


Final damage mask

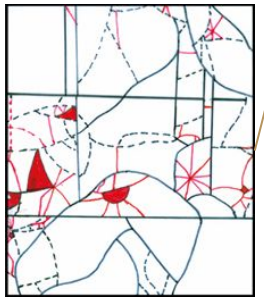


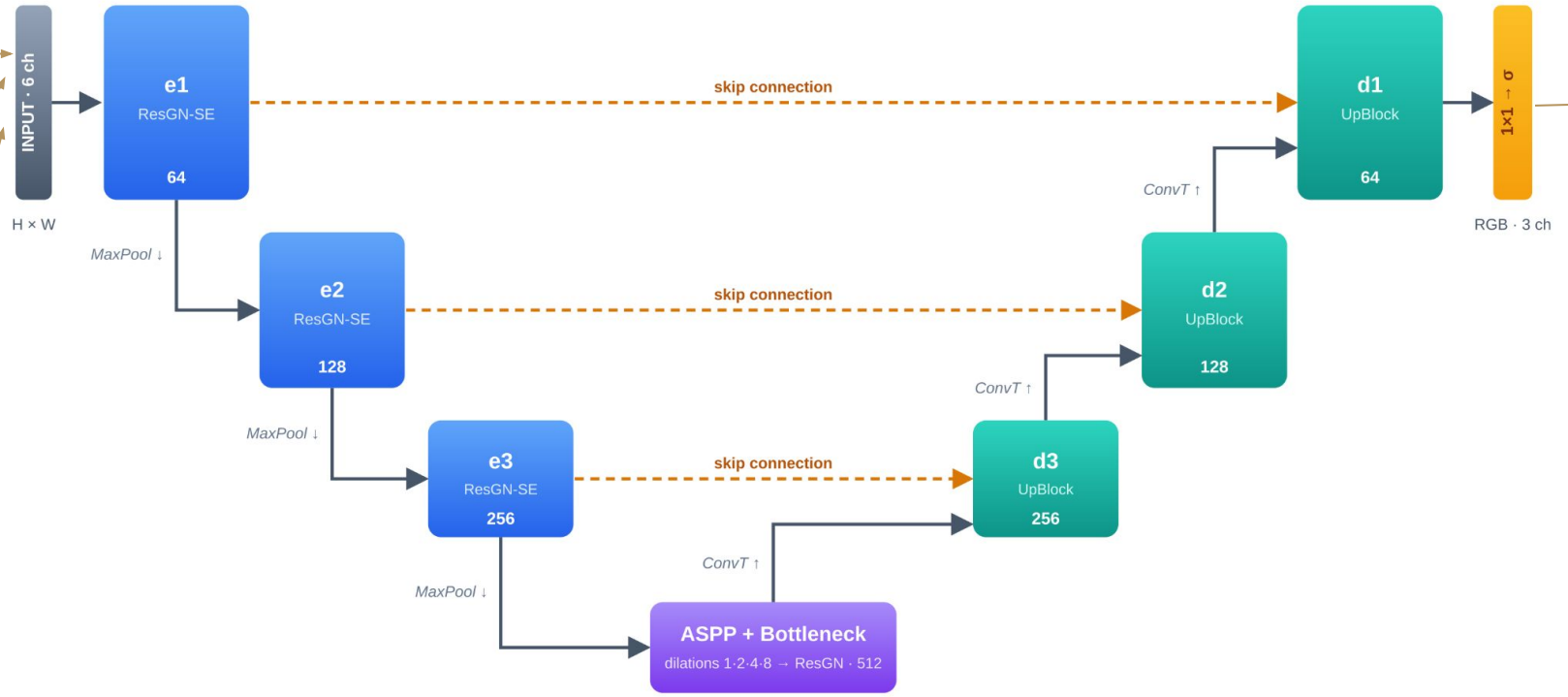
Manual correction

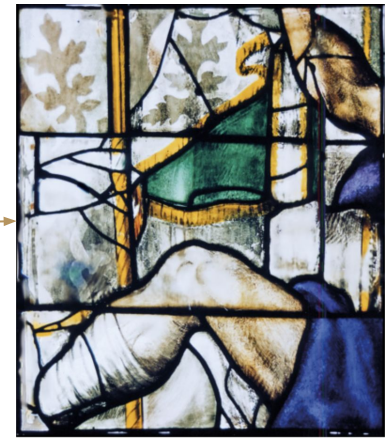
Reference-guided inpainting





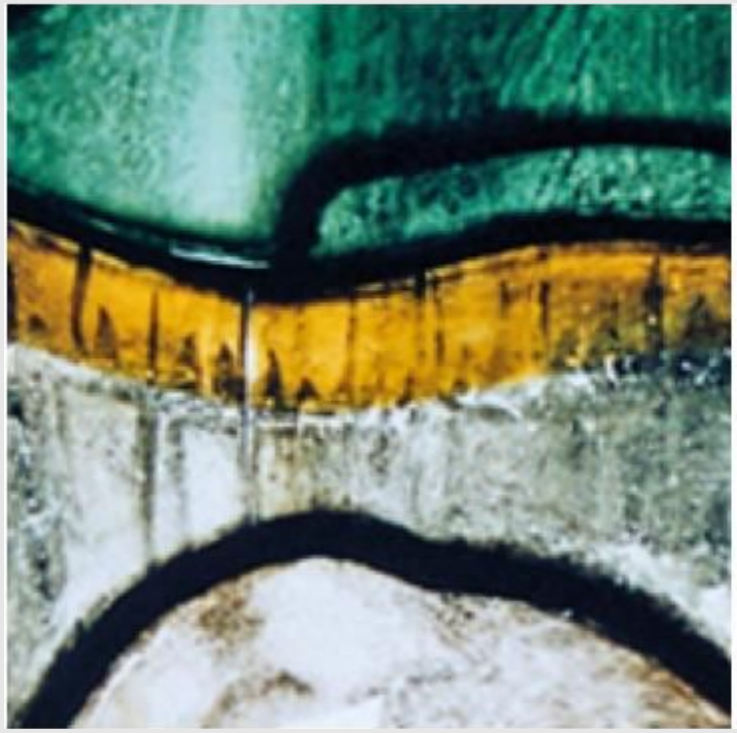




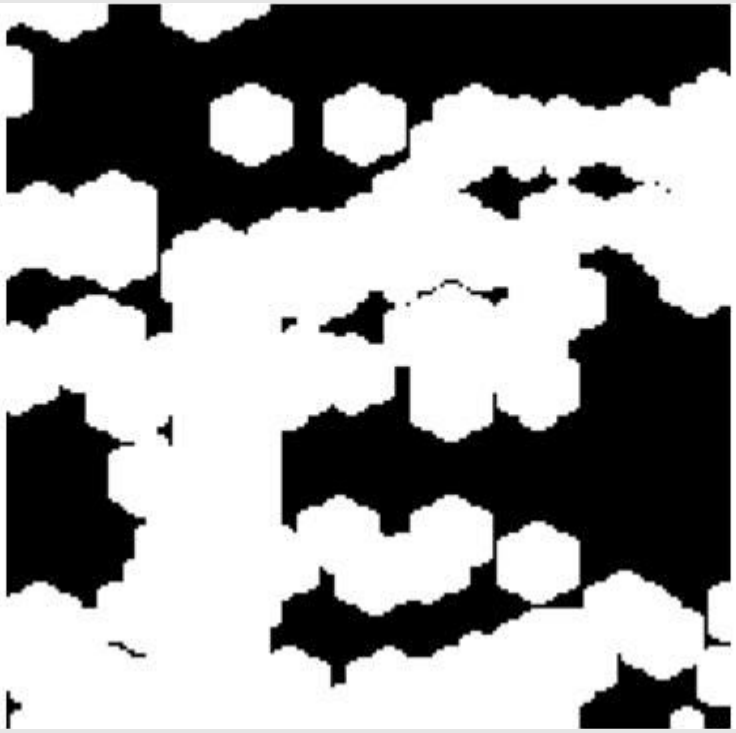


Convolutional UNet6 neural network

Training without prior data: self-supervised training



Original non-damaged image patch

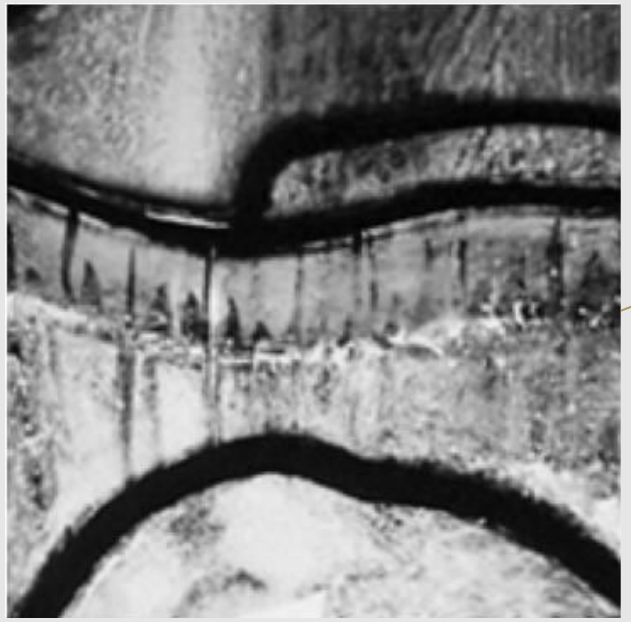


Random mask



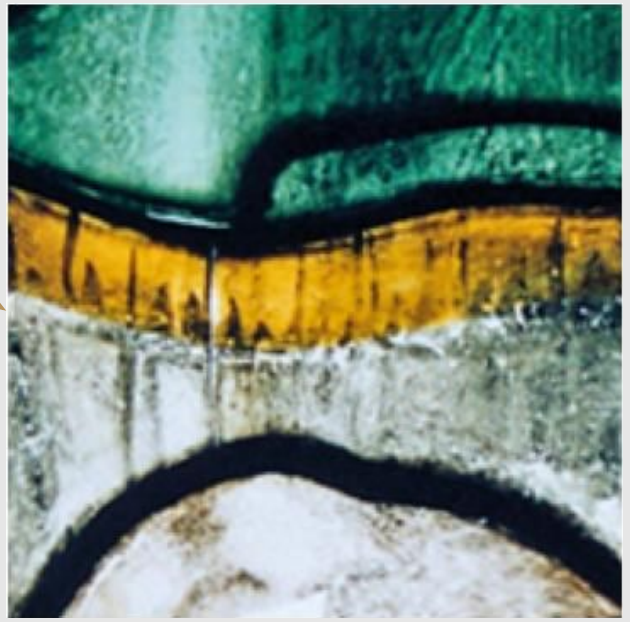
Result: artificially damaged image

Self-supervised training





Neural network UNet6



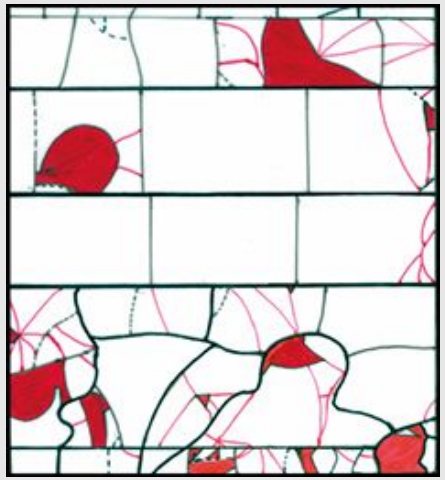
A web-based user interface



Demonstration









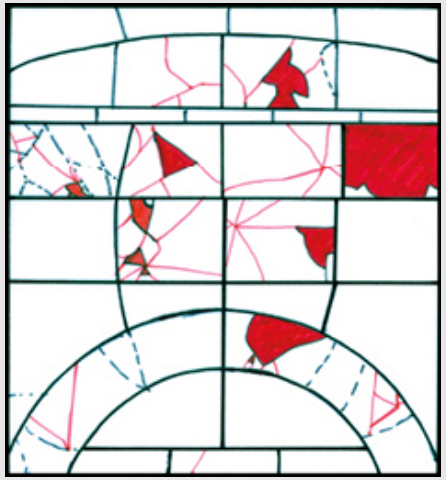


BALaT picture a023618

Demonstration











BALaT picture a023634

Demonstration





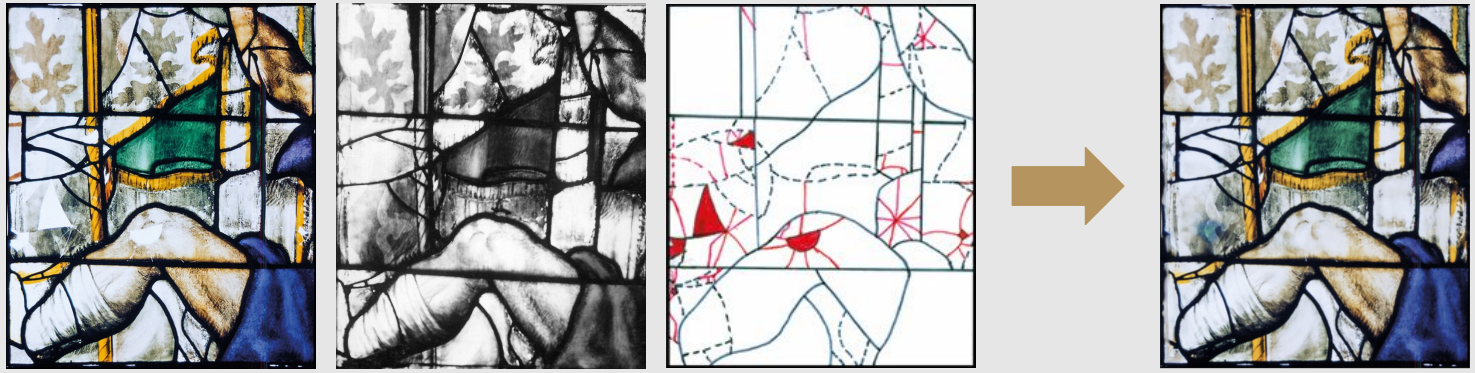




BALaT picture a023611

The importance of documentation and open data

- KIK-IRPA database BALaT, where the archive pictures are available
  https://balat.kikirpa.be
- Structured open data under a Creative Commons license
  https://zenodo.org/records/17160139
- Open-source code
  https://gitlab.com/nnadisic/virtual-restoration-of-stained-glass-windows



BALaT picture a023069

Conclusion









Conclusion





Beyond virtual restoration, this project has the potential
to support and prepare the restoration itself.

Conclusion



AI-generated image



Gracias. Bedankt. Merci. Thank you.

Contact
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Code and data
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