



3D-printed Replicate Mimicking Bone Structure

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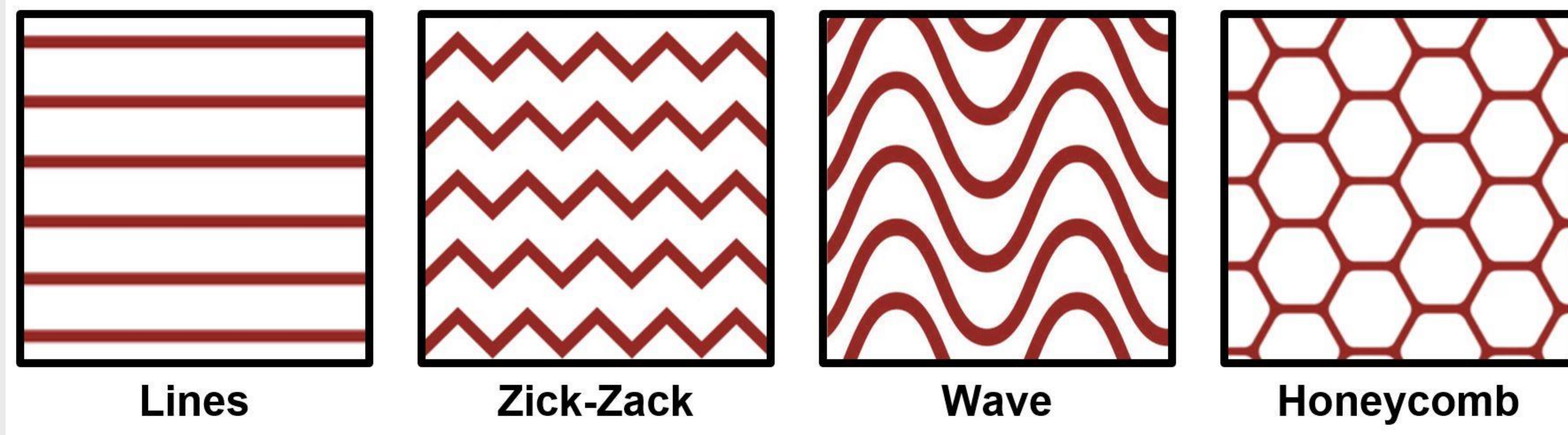
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Introduction

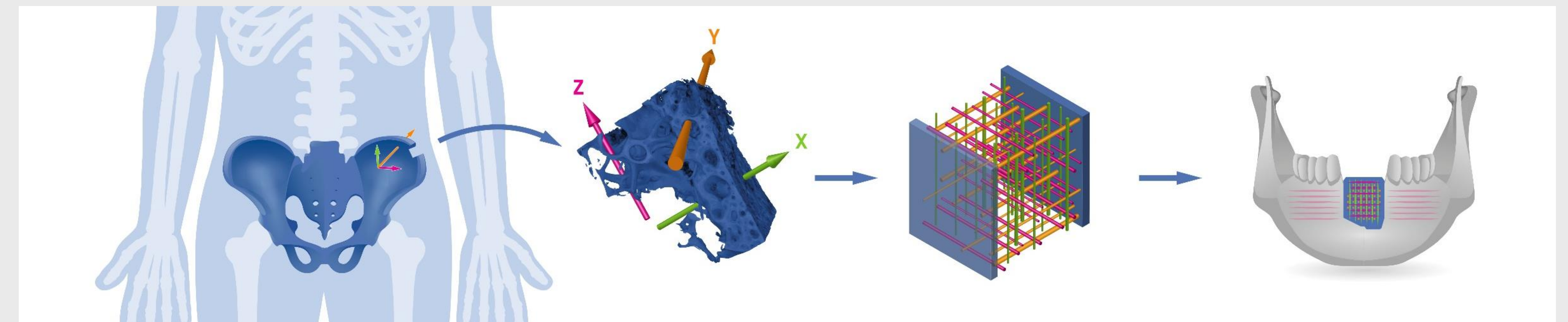
The challenge

- The efficacy of non-autologous bone graft substitutes is limited
- Augmentation heights $> 5\text{mm}$ can only be achieved with autologous bone grafts
- So far produced scaffolds as non-autologous bone substitutes exhibit unphysiological structures



Bone from Iliac Crest

- In particular, the iliac crest graft is proving superior to other graft types for augmentation of the alveolar ridge
- Significant differences have been found with regard to
 - Proliferationrate *(Wein, Fretwurst et al. 2015)*
 - Protein expression level *(Wein, Huelter-Hassler et al. 2018)*
 - Proteom expression level *(Fretwurst et al. 2022)*
 - Vascular network *(Rothweiler et al. 2022)*

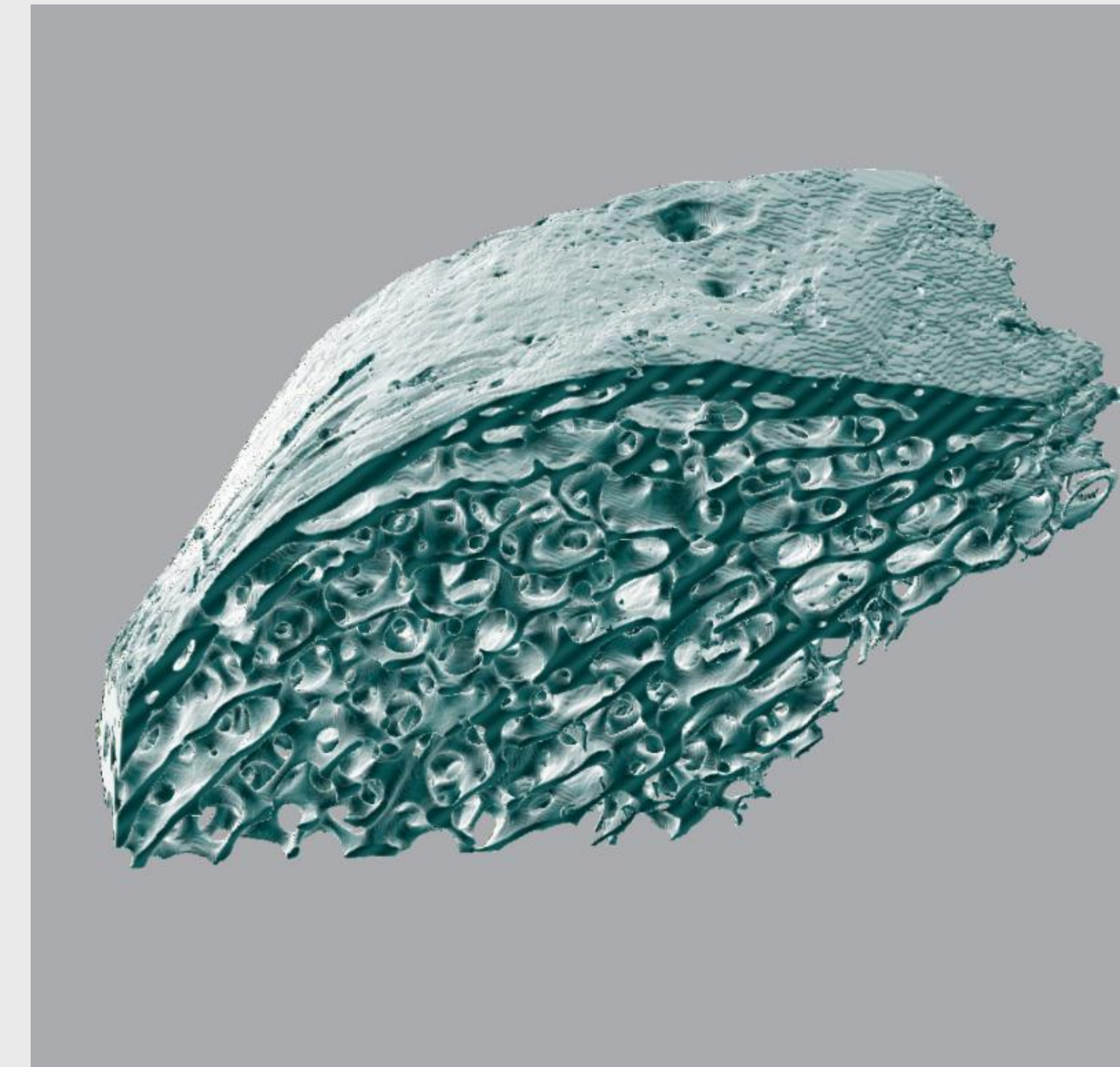


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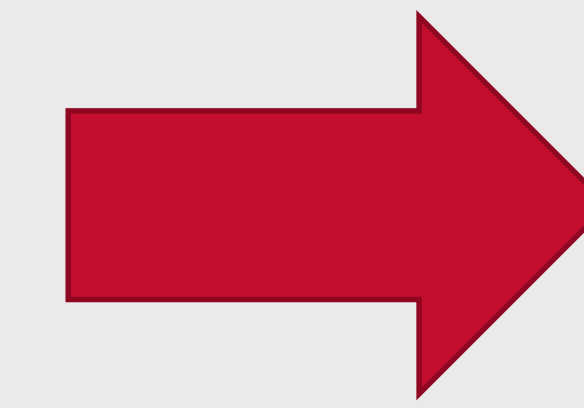
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Materials and Methods

- STL creation from a bone fragment of the iliac crest using synchrotron μ CT (2.3 μ m voxel size).
- 3D printing of a replica of the bone fragment using SLM printing technology.
- Examination of the printed replicas using μ CT analyses.



MPR after synchrotron
 μ CT scan with 2.3 μ m
voxel size



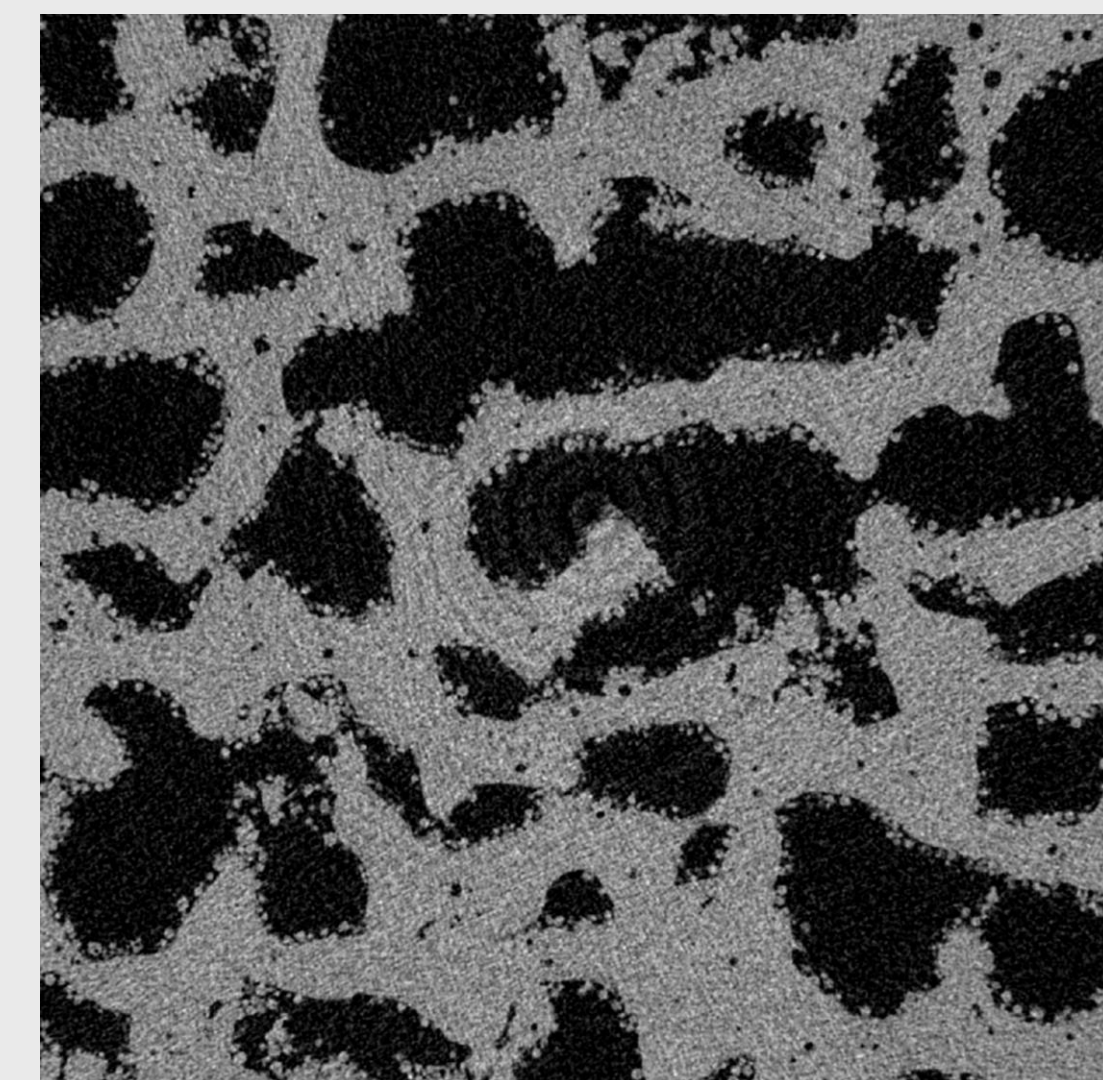
Printed replica in
titanium

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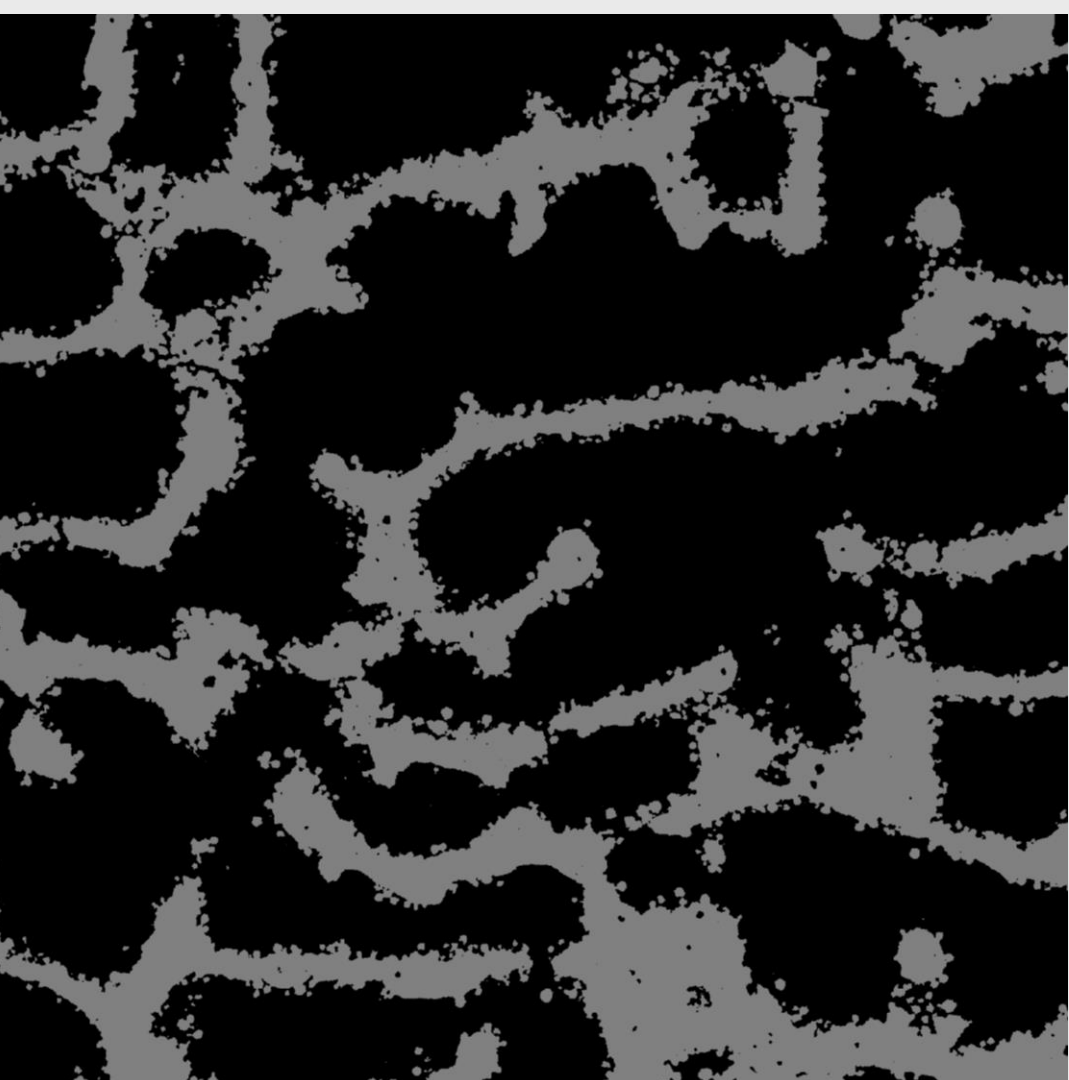
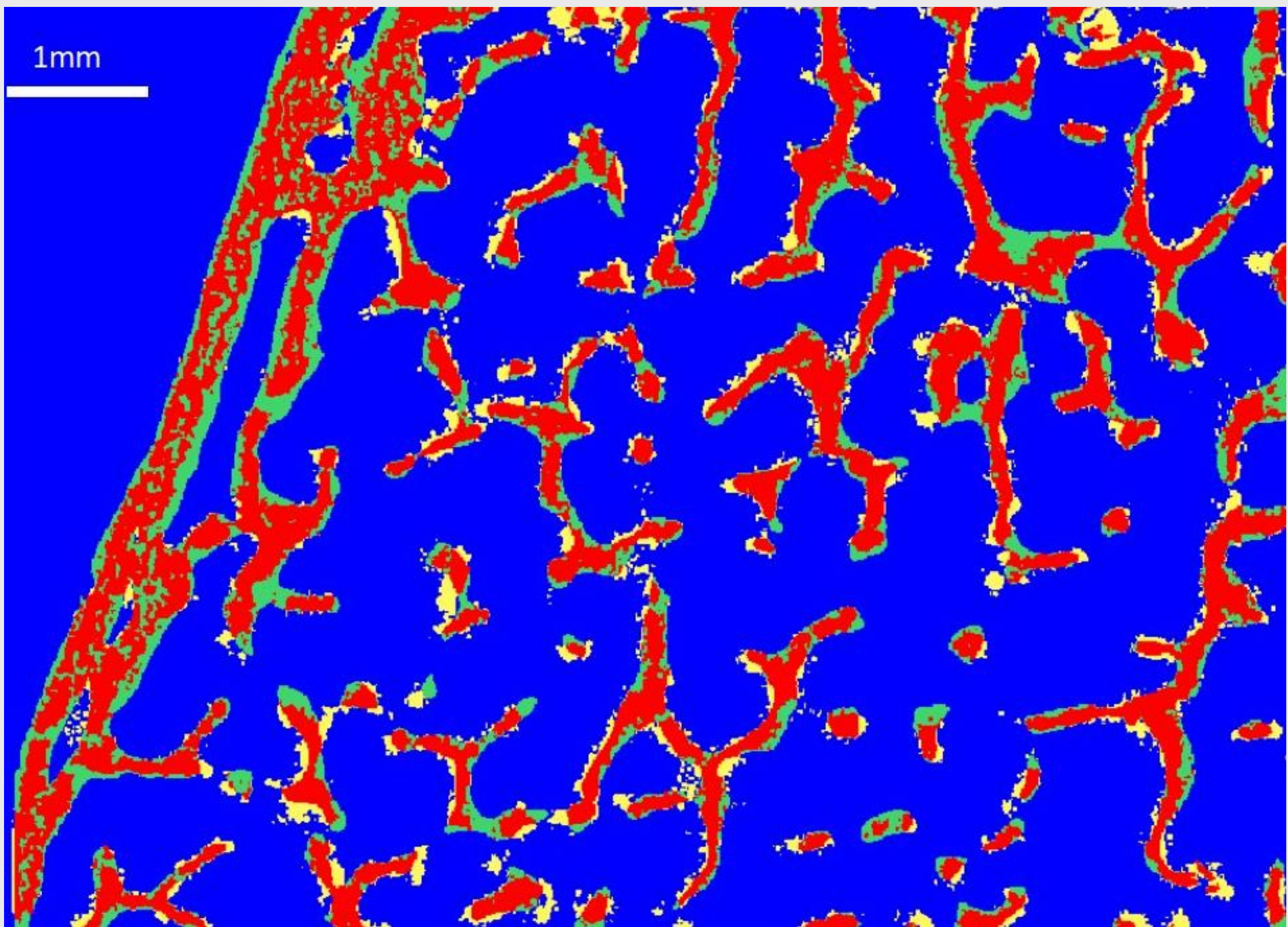
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Results

Conventional
setup

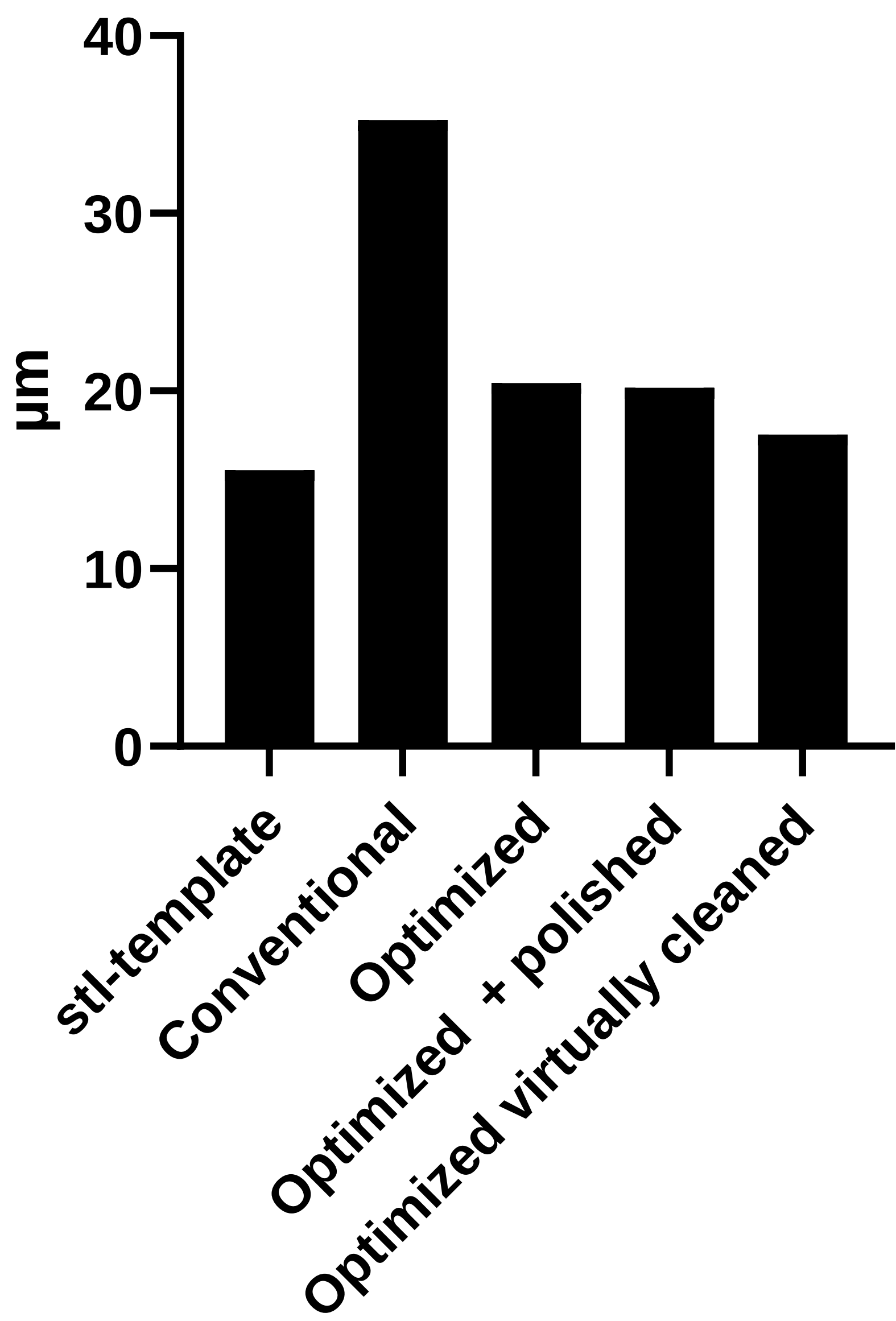


Optimized
setup

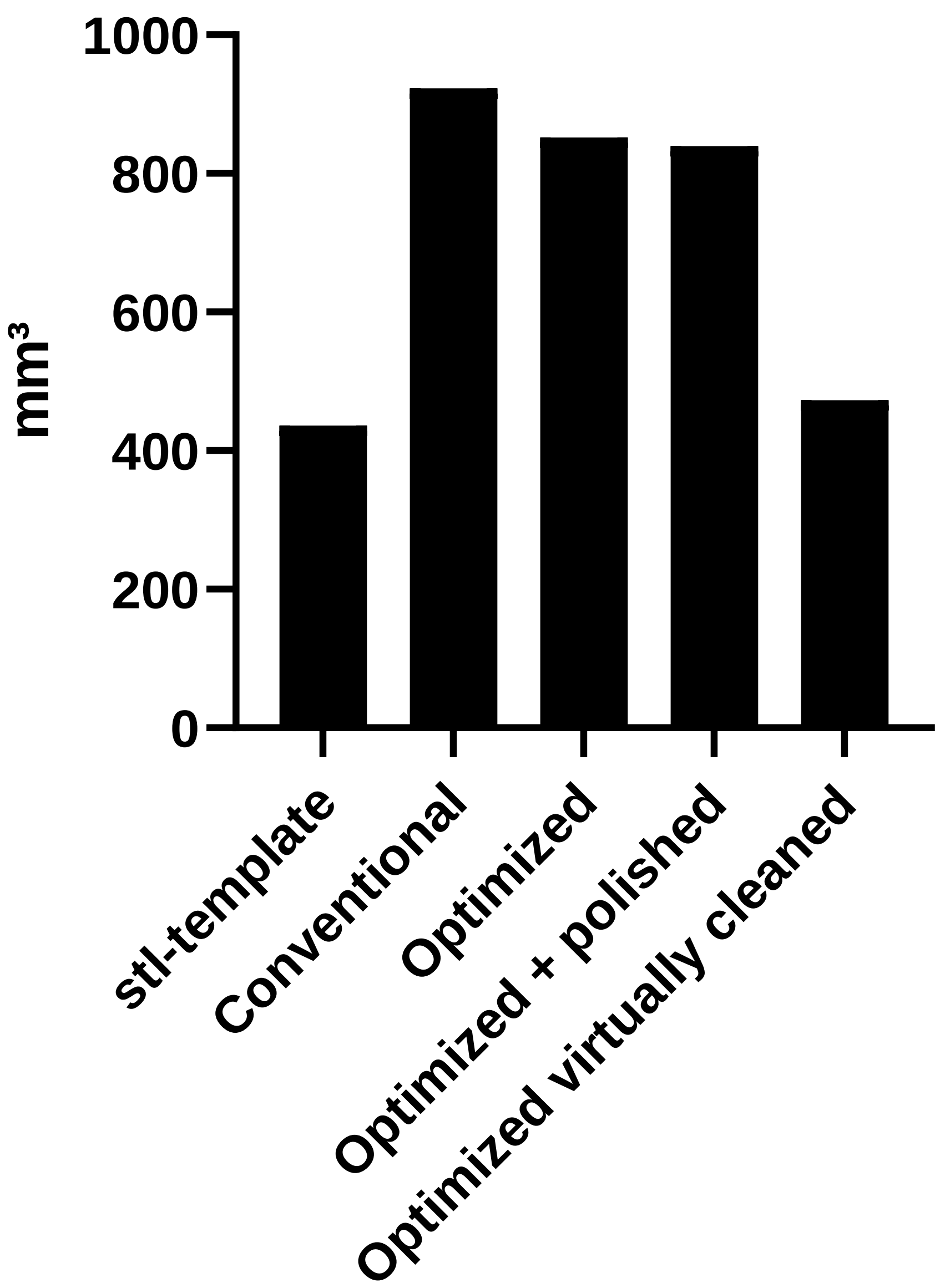


Green: Bone
Yellow: Optimized setup
Red: Overlap

Volume



Surface area



Conclusion

- Using SLM technology, even complicated geometries such as bone structures can be printed out of titanium.
 - It is possible to achieve similar morphometry parameters to the original template through optimization of process parameters.
- The superiority of scaffolds with multidimensional physiological architecture over conventional scaffolds needs to be proven in the next step.