Postdoc Position

High Performance Digital Volume Correlation
for the characterization of lattice structures

General context. This research fellowship is part of Project AVATAR, funded by the French National Research Agency (ANR), involving universities in Toulouse, Paris, and Lausanne (CH). The project leverages advances in Metal Additive Manufacturing (AM) and digital imaging tools, which are transforming materials mechanics. Metal AM processes, such as Selective Laser Melting (SLM), enable the fabrication of high-performance products with significant weight savings, crucial for cleaner mobility and space applications [1].

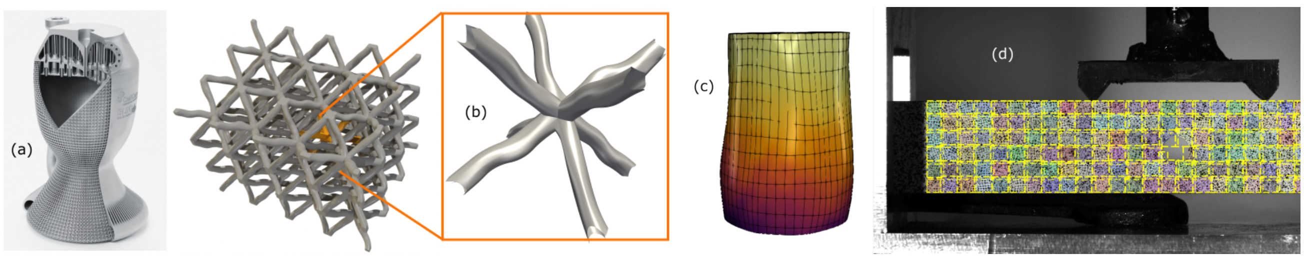

Fig. 1. (a) 3D printed (SLM process) thrust chamber of a rocket engine (cellcore3d.com), (b) CAD-based representation of the as-manufactured lattice [4], (c) CAD-Based DVC and (d) domain decomposition approach in FE-DIC.

While offering exceptional design freedom, metal AM introduces process complexities that result in strut-level defects, causing discrepancies between the ideal CAD model ("as-designed") and the actual geometry ("as-manufactured"). Characterizing the mechanical impact of these defects involves *in-situ* experiments on lattice samples. X-ray Computed Tomography (CT) provides 3D insights at the micro-meter scale during different loading stages. To quantitatively analyze these volume images and extract relevant mechanical fields, 3D image registration techniques, or Digital Volume Correlation (DVC) [3], are employed. These measurements are then used to calibrate numerical models, utilizing Finite Element or Isogeometric Analysis frameworks [3,4].

Challenge. The goal of this postdoctoral position is to develop an efficient computational algorithm using domain decomposition methods to solve global digital volume correlation problems in parallel. This approach combines the benefits of Global-DIC (solution continuity, physics coherence, simulation linkage) with the parallelization advantages of subset methods, as illustrated in Fig. 1(c). Domain decomposition methods are well-suited for parallel computing on distributed architectures [2]. The resulting algorithms may ultimately be implemented on the massively parallel machines of regional or national HPC facilities.

Supervision. J.C. Passieux, P. Oumaziz, and R. Bouclier (INSA, ICA, Toulouse) and P. Jolivet (Sorbonne, LIP6, Paris).

Profile sought. PhD with expertise in computational mechanics and/or applied mathematics with skills in finite elements, numerical analysis, optimization, computer programming (Python). Basic knowledge in image analysis.

Start Date. Flexible, between now and October 2025. **Duration :** 12 months.

Application : CV, cover letter, to be sent to passieux@insa-toulouse.fr and pierre.jolivet@lip6.fr.

[1] Blakey-Milner, B., Gradl, P., Snedden, G., Brooks, M., Pitot, J., Lopez, E., Leary M., Berto F., & du Plessis, A. (2021). Metal additive manufacturing in aerospace : A review. *Materials & Design*, 209, 110008.

[2] V. Dolean, P. Jolivet, F. Nataf. (2016) An Introduction to Domain Decomposition Methods : Algorithms, Theory, and Parallel Implementation. SIAM, 978-1-61197-405-8.

[3] A. Rouwane, P. Doumalin, R. Bouclier, J.-C. Passieux and J.-N. Périé (2023). Architecture-Driven Digital Volume Correlation : application to the analysis of in-situ crushing of a polyurethane foam. *Experimental Mechanics* 63(5), p.897-913.

[4] D. Bichet, R. Bouclier, J.-C. Passieux and J.N. Périé. (2025) Isogeometric multipatch surface fitting in tomographic images : Application to lattice structures. *Computer Methods in Applied Mechanics and Engineering*. In Press.