Highly Anisotropic Battery Meshing

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Cell design became a major challenge in the path for a greener future. Simcenter STAR-CCM+ introduced new tools to facilitate the design exploration of batteries. We present our new meshing approach that automates the discretization process, while ensuring the fastest simulation time, so as to maximize Engineers' productivity. We produce highly anisotropic meshes on a curved stack of materials while respecting local sizing constraints. Our method is a two steps process, we first generate a high-quality quad-dominant anisotropic mesh on the top of the battery, that is then swept using standard approaches to obtain a volume mesh used for simulation. The surface mesh is obtained using our new quasi-structured approach. We apply the Periodic Global Parametrization method [1] to the process of creating the highly anisotropic mesh. This enables precise size variation control, while maximizing element quality. Our meshes are generated to offer similar convergence quality and speed to carefully hand-crafted structured meshes, while requiring a minimal user interaction, thus being orders of magnitude faster to generate.

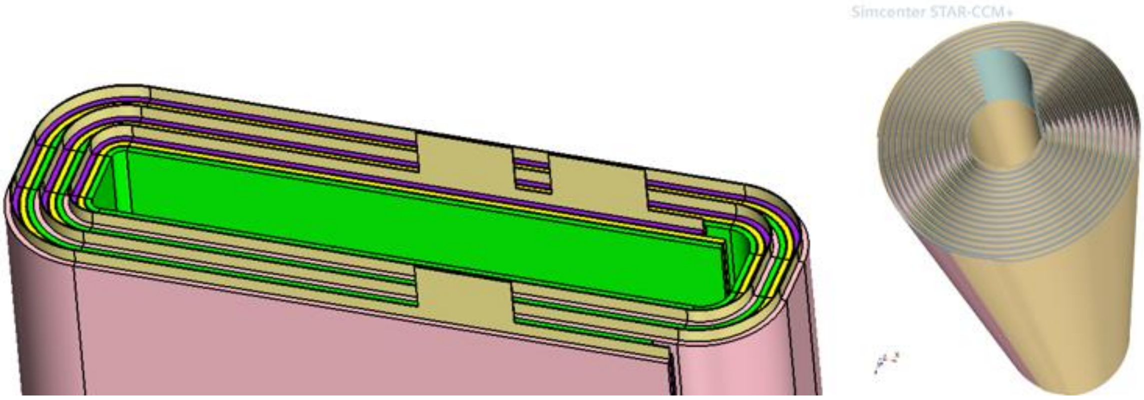

Figure 1 Example of the kinds of geometries simulated using Simcenter STAR-CCM+'s Cell Designer

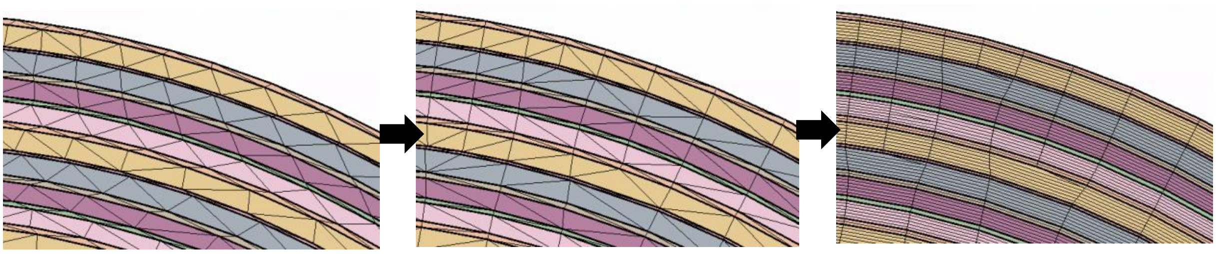

Figure 2 Our surface mesh generation proceeds in 2 steps; we start from a triangle mesh having the user-prescribed edge length along curves (left). We then align vertices along those curves using a Periodic Global Parametrization approach [1]. And then finally, we apply local anisotropic patterns to create the desired mesh.

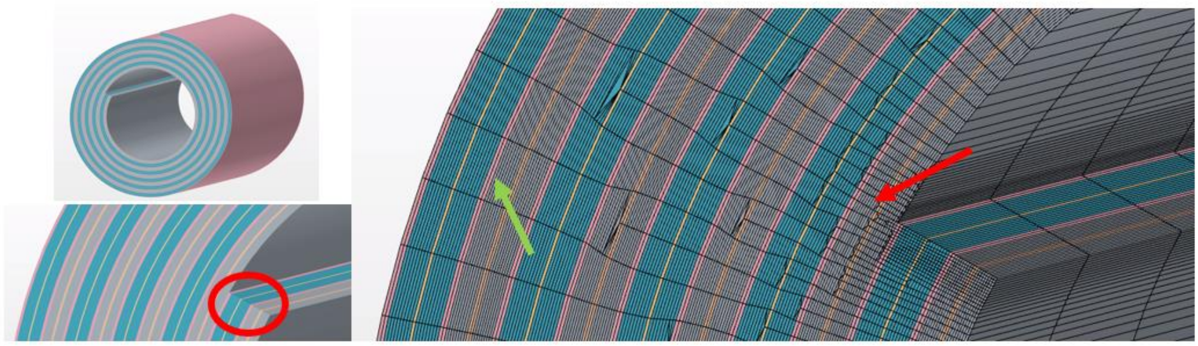

Figure 3 Cell Design simulations may require a finer mesh in certain locations (red circle). Our algorithm can smoothly transition from isotropic regions (red arrow) to anisotropic ones (green arrow). This makes it possible to minimize the number of required degrees of freedom, while still maximizing the overall mesh quality.

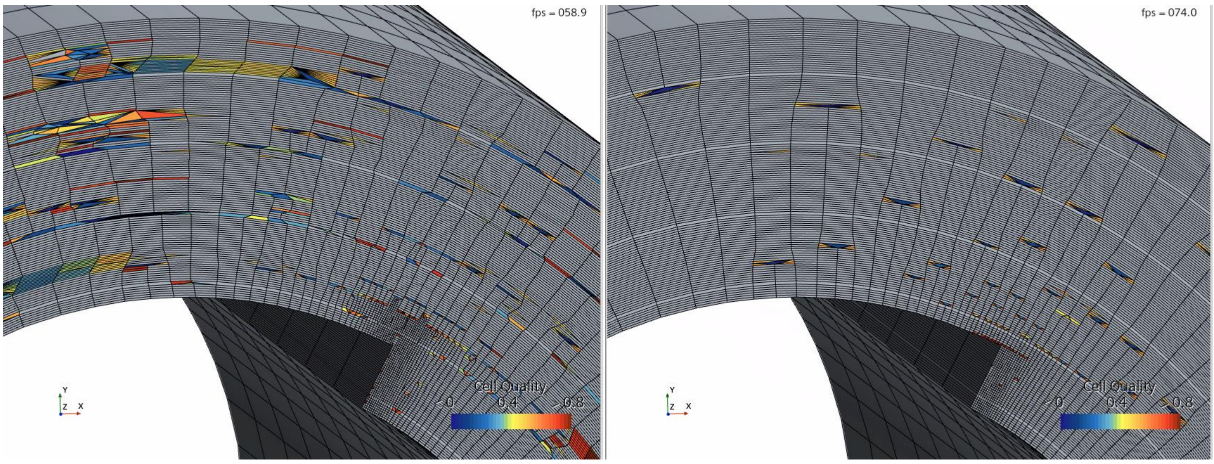

Figure 4 Our approach produces meshes vastly superior to the prior heuristic-based alignment approach driven by an advancing front algorithm.

[1] Periodic Global Parameterization. Nicolas Ray, Wan Chiu Li, Bruno Lévy, Alla Sheffer, Pierre Alliez. ACM Transactions on Graphics, 2006.