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Co-processing and post-processing of high order polynomial solutions on massively parallel systems

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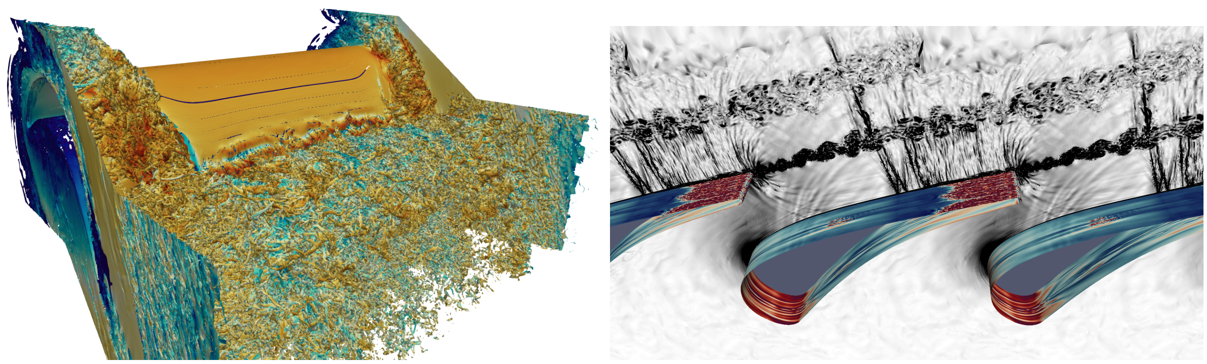

(a) (b)

Figure 1: Visualization of high-order flow solution generated by a discontinuous Galerkin CFD method. (a) Horse-shoe vortices interacting with suction side separation on the MTU T161 LP turbine cascade at $Re_{2s} = 90.000$ - Q-criterion colored by velocity, shown on the suction side. (b) Bypass turbulence illustrated by the heat flux on the surface of the LS89 HP turbine blade cascade at $Re_{2s} = 1.2e6$, along with instantaneous normalized density gradient on the periodic plane.

Recently high-order finite element methods have gained considerable attention, not only in the research community, but also in industry. However, the lack of visualization tools able to handle a large number of *degrees of freedom (dof)* has been a major bottleneck for the analysis of high-order finite element solutions at scale.

Recently, Cenaero has developped two capabilities to perform respectively traditional post-processing and more advanced co-processing of data generated by its massively parallel high-order discontinuous Galerkin CFD code Argo. For offline post-processing and visualization of high-order solutions, we present a new ParaView plugin that integrates Gmsh used as an external library. This plugin therefore combines respectively ParaView's scalability in parallel and Gmsh's ability to apply h-refinement of the initial grid followed by solution interpolation on the refined grid for visualization of high-order fields, thus enabling parallel visualization of high order polynomial solutions in client-server mode. In a second stage, this capacity has been extended to a co-processing interface based on the Catalyst library, which enables live in-situ visualization of high-order solutions generated by Argo. These new capacities are demonstrated with the visualization of the flow solution for two turbomachinery applications, i.e. the full span MTU T161 LP turbine blade cascade and the LS89 HP turbine blade cascade illustrated in Fig. 1.