APPLICATION OF DISCONTINUOUS GALERKIN METHOD. LARGE SCALE PROBLEM : CANNON BLAST MODELING

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The Discontinuous Galerkin method has reach a level of maturity that permits it to be integrated with state of the art discretization and computation technique and applied to real world large scale problem. Using the framework offered by Trellis [1], a general purpose object oriented discretization library, a discontinuous Galerkin method has been implemented to solve Euler equations [2]. Anisotropic mesh refinement in three-dimensions [3] permits us to achieve a high degree of accuracy near transient and sharp shocks structures. A parallel version of the code, using MPI and Autopack as a message passing library, permits us to take advantage of the computational power of parallel clusters to solve transient problem on millions of degrees of freedom.

The discontinuous galerkin methods is used to discretize the equations in the space domain. A forward Euler or Runge-Kutta scheme is used to obtain an explicit formulation in time. A system of discrete equations is then obtained for each element, containing the contributions from inter-cell flux. This uncoupled structure of the system of equation permit to over come the otherwise too constraining CFL conditions by allowing a local time stepping procedure.

The resulting code has been applied in collaboration with Benet Laboratory to predict the flow and pressure history during the blast of a cannon. The flows developed demonstrate highly interacting structures of shocks which is efficiently captured by our adaptive discontinuous Galerkin scheme. The shocks structures are highly depend on the muzzle design. The goal is to optimize the design, to limit for example, the high pressure wave that propagate behind the cannon.

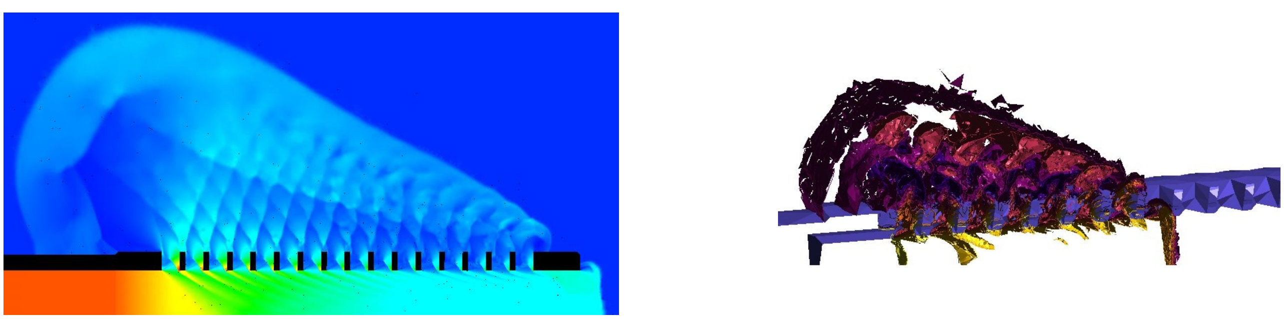

Figure 1: Shocks structure around a Muzzle.

References

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[2] J. Remacle, J.E. Flaherty, M.S. Shephard. “ An Adaptive Discontinuous Galerkin Technique with an Orthogonal Basis Applied to Compressible Flow Problems," *SIAM Journal on Scientific Computing*, 2002, in press.
[3] J. Remacle, L. Xiangrong , N. Chevaugeon and M.S. Shephard, “Transient Mesh Adaptation Using Conforming and Non Conforming Mesh Modifications" *11th International Meshing Roundtable*, September 2002.